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A PROGRAM FOR COMPUTING STEADY INVISCID THREE-DIMENSIONAL SUPER--ETC(U)
MAY 77 J M SOLOMON, M CIMENT, R E FERGUSON

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A PROGRAM FOR COMPUTING STEADY INVISCID THREE-DIMENSIONAL SUPERSONIC FLOW ON REENTRY VEHICLES, VOL. II, USER'S MANUAL

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ADVANCED WEAPONS DEPARTMENT

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A comprehensive computational procedure is presented for predicting the supersonic region of the flow field on advanced reentry vehicle shapes in steady flight at pitch and yaw. The procedure utilizes explicit second order accurate finite difference methods applied to the conservation law form of the steady inviscid flow equations. Improved numerical methods are used at the body surface and the bow shock wave. Provisions for treating body

(cont on p 1473 B)

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20. (cont.) (for p 1473A)
geometries with discontinuous slopes are also included. Either perfect gas or real gas equilibrium thermodynamic properties can be used.

The computational procedure is implemented as a fortran computer code which provides a practicable representation of the inviscid flow field and the resulting aerodynamic force and moment on the vehicle. This volume

In the companion report (Vol. I), the analytical and numerical development of the procedure is presented and the associated computer code is described. This report (Vol. II User's Manual) contains detailed instructions for operating the code and interpreting the output results.

SUMMARY

This report describes the analytical, and computational aspects of a computer program for predicting inviscid flow fields and aerodynamics on realistic reentry configurations. This work was performed by members of the Mathematics and Engineering Analysis Branch of NSWC/WOL. The initial code development was supported by the Naval Sea Systems Command under the Aeroballistic Reentry Technology (ART) program with some of the fundamental analytical and numerical work supported by NSWC Independent Research Funds. Most of the final code development and documentation was supported by the Air Force Space and Missile System Organization under the technical management of the Aerospace Corporation.

The authors gratefully acknowledge the efforts of Mr. R. Feldhuhn, NSWC coordinator for the ART program, who was responsible for initiating the present work and whose continued interest and support throughout the investigation was invaluable. The authors are also indebted to Mr. M. Lyons and Dr. E. Ndefo of the Aerospace Corporation for several stimulating technical discussions which lead to important improvements in the final code.

C. A. Fisher

C. A. FISHER
By direction

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1. Title

A Program for Computing Steady Inviscid Three-Dimensional Supersonic Flow on Reentry Vehicles; Vol. II: User's Manual

2. Identification

The following user's manual is intended for instruction on how to use the computer program D3CSS (see Ref. 1).

3. Configuration

The computer program was written for use on the CDC 6000 Series or 7000 Series. The program is coded in FORTRAN IV Source language.

4. DESCRIPTION

4.1 Purpose: The D3CSS program computes the inviscid flow field in the supersonic region (c.f., Fig. 1) on arbitrary shaped reentry bodies in pitch and yaw. The program also integrates the surface pressures to determine the aerodynamic force and moment on the body.

4.2 Method: The program uses second order accurate finite difference methods to solve numerically the inviscid flow equations in conservation form. The calculation is performed in a body oriented cylindrical coordinate system shown in Fig. 1. At the bow shock wave the Rankine-Hugoniot conditions are satisfied. The program has provisions for body shapes having discontinuous slopes. For a detailed description of the methods used in the program, see ref. 1.

4.3 Assumptions: The program assumes that:

(i.) The flow is inviscid and the gas obeys either the perfect gas law with a constant ratio of specific heats, γ (GAMMA), or a real gas equation of state.

(ii.) The axial component of velocity (i.e., the velocity in the z direction in Fig. 1) is supersonic. (The appearance of subsonic axial velocity anywhere in the shock layer will produce a program halt.).

(iii.) At some axial location, $z = z_o$, the flow field is completely known. The plane $z = z_o$ is referred to as the initial plane (see, Fig. 1).

(iv.) The body shape is described in a fixed cylindrical coordinate system shown in Fig. 1; however, there are exceptions in the case of a bent nose cone (see sec. 11 for details).

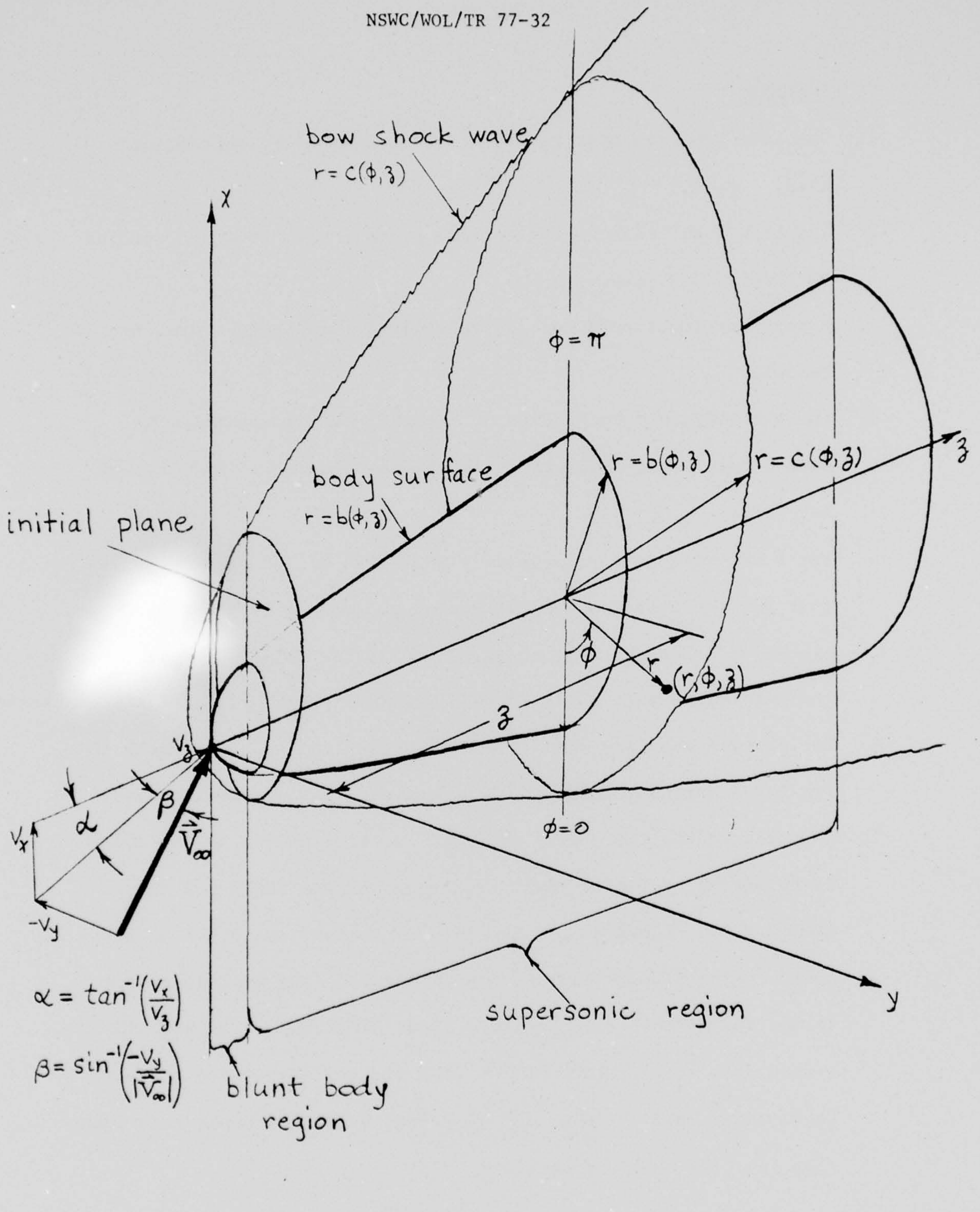


Fig. 1. Computational regions and cylindrical coordinate system for reentry vehicle inviscid flow calculations.

5. REQUIREMENTS

1. The body geometry must be specified in a separate subroutine (see, Sec. 6).

2. The flow field data on the initial plane $z = z_o$ must be supplied on input TAPE3 (see, Sec. 7).

3. A separate input card deck is required for each case (see, Sec. 7 below).

4. The thermodynamic properties of the gas must be specified in subroutines RGAS, HRGAS, ENTRY ARGAS (see secs. 11.5 and 11.6 of Ref. 1).

5. For a run with more tangential planes than 25 and/or more radial points than 20, the corresponding dimension statements in the COMMON blocks will need to be changed. Also in the MAIN, D3CSS, the DATA statement: DATA (NCMAX=20),(MCMAX=25) will need to be changed.

6. The program requires less than 110K octal locations of memory to run for a maximum of 20 radial points and 25 tangential planes.

7. The program has the special recovery routine called RECOVR which is supported by CDC on their operating systems SCOPE 3.4 and KRONOS 2.1. RECOVR allows the program to continue after an ERROR MODE. Using RECOVR enables the printing of the wall pressures, forces and moments even if there is an ERROR MODE. If the operating system does not support RECOVR, then the RESTART option of using TAPE15 will have to be used. (see Sec. 9) or the Error Mode Update (see Sec. 12) could be used.

6. SPECIFICATION OF BODY GEOMETRY

6.1 The user must specify the body geometry in the subroutine BODY. In the event that a body is to be computed which is not included in the version of BODY in the delivery package (see, Sec. 6.2), a new BODY subroutine must be written. A description of this subroutine containing a list of all quantities which must be specified is given in Sec. 12.1 of ref. 1.

6.2 The version of BODY contained in the delivery package describes a family of body shapes subject to the following criteria:**

1. The baseline body consists of a nose section followed by a multiple conic with at most 8 conical portions (see Fig. 2a). The nose section is either a sphere (tangent to the first cone portion) or a bent sphere-cone (see Fig. 2e).
2. The rear of the body may be rounded (see Fig. 2b) or it may have an elliptical flare (see Fig. 2c). It may not have both.
3. The body may have a wind ($\phi^* = 0$), side ($0° < \phi^* < 180°$), and lee ($\phi^* = 180°$) cut sequence. By a cut sequence at $\phi = \phi^* =$ PHIS we mean a sequence of cuts formed by passing as many as four planes, all normal to $\phi = \phi^*$, through the body.* (See Fig. 2d)
4. A finite span flap may be placed on the second part of a cut section; (Note: a flap is modeled as a wedge. At the end of the flap the wedge is continued with zero angle (see Fig. 2d)
5. A cut sequence may not begin after rounding begins nor on the flared section.

The various parameters required to define a specific geometry are read-in from cards (see Sec. 7).

*All body shapes are symmetric; hence a side cut at ϕ^* implies the same for $360-\phi^*$.

**All length dimensions are assumed non-dimensionalized by the radius of the nose (see Fig. 2e).

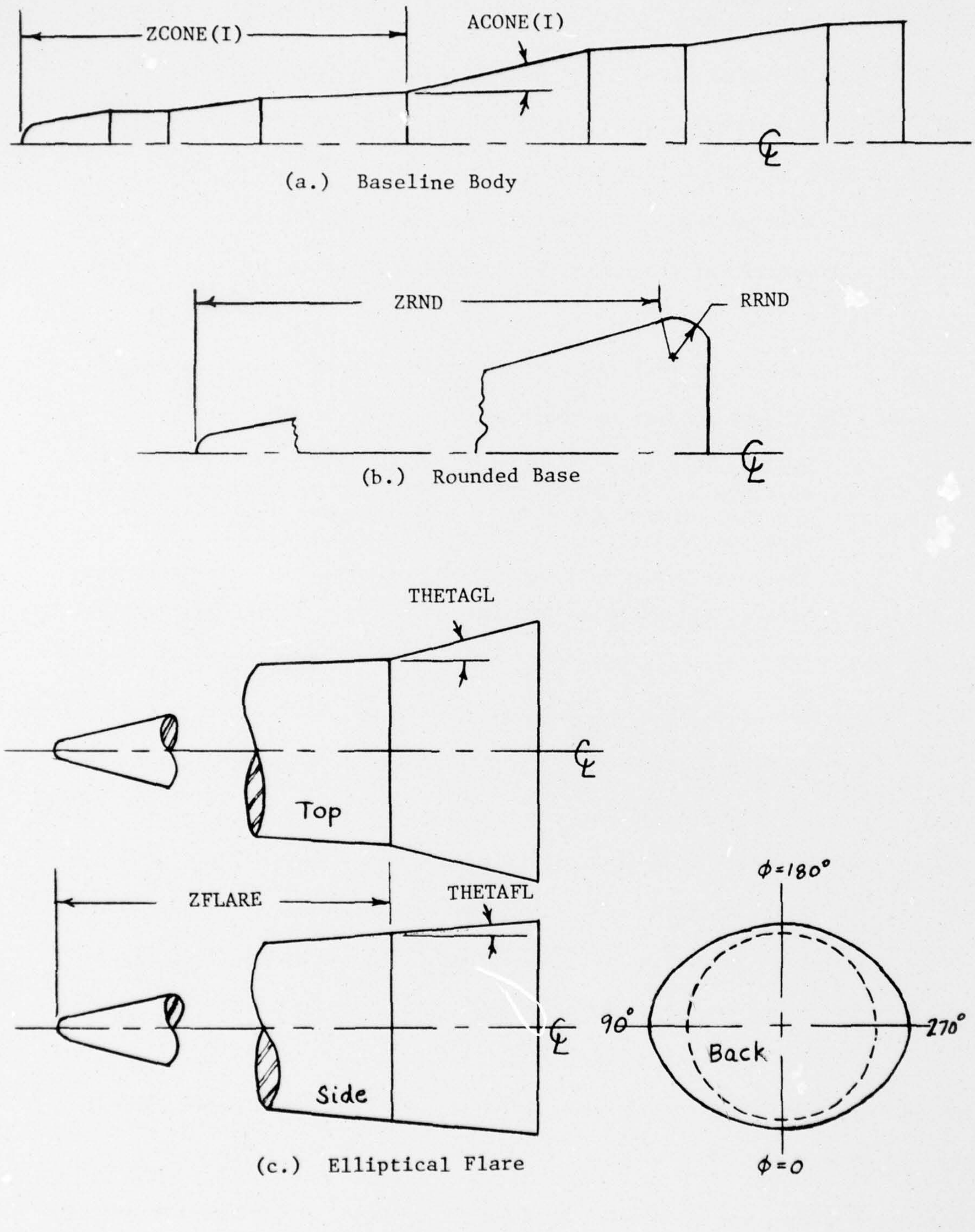


Fig. 2, Uncut Body Geometries

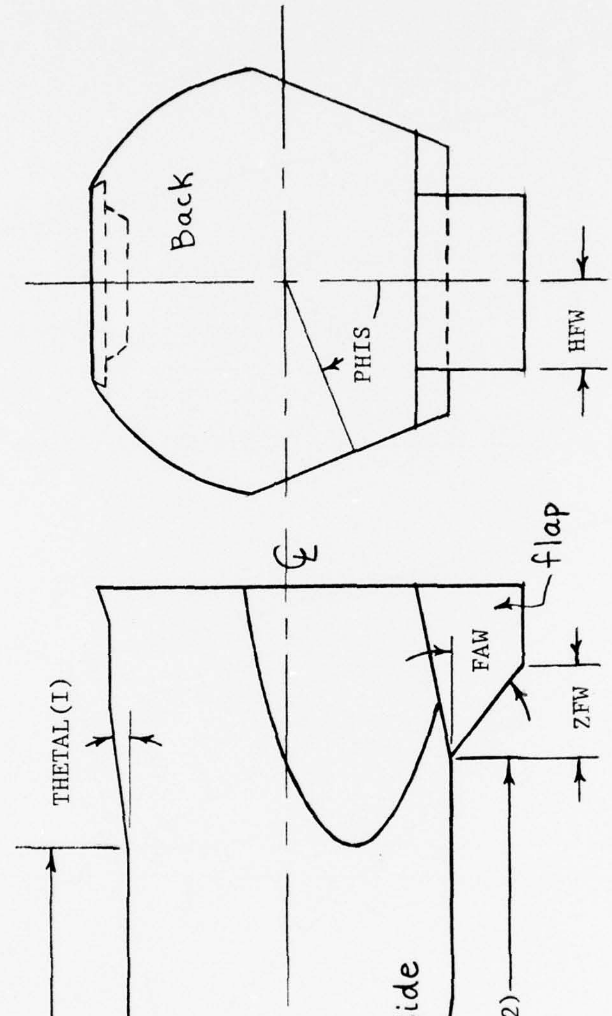
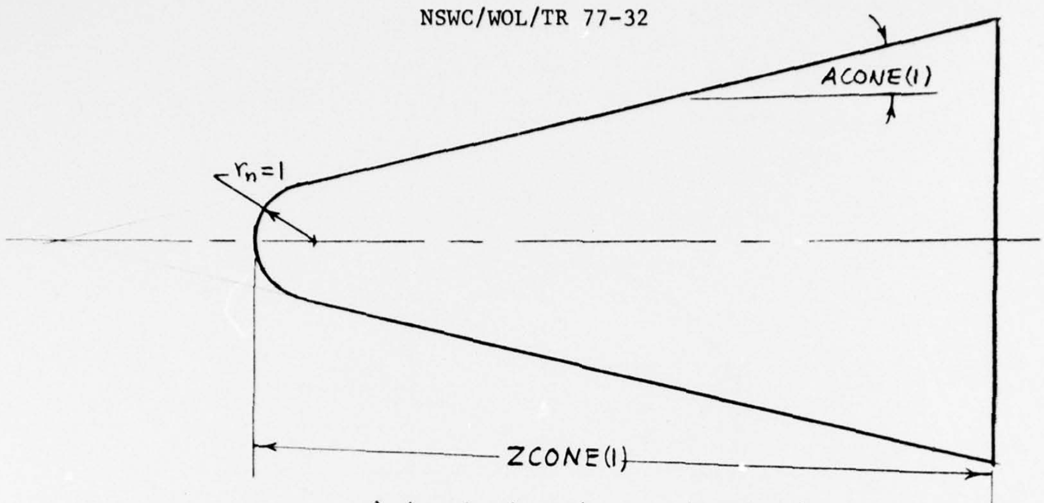
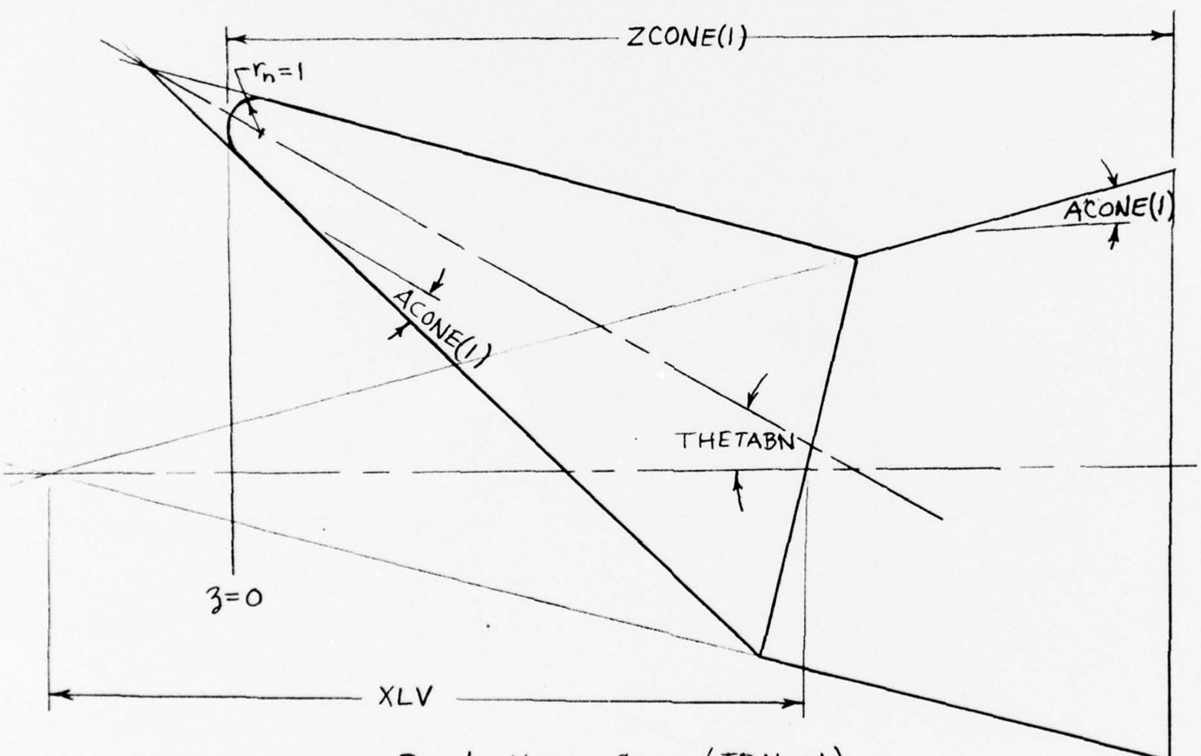


Fig. 2d, Cut and Flap Geometry



Spherical Nose (IBN=0)



Bent Nose Cone (IBN =1)

Fig. 2e, Nose Section Geometry

7. INPUT

There are two forms of input to the program.

7.1 Tape Input: The initial flow field data required to begin the calculation is on input TAPE3. This data may be obtained from a previously saved restart file (see, Section 9) or (to begin the calculation) by running a suitable blunt body program (e.g., that of ref. 2). The specific read statement in the program is:

```
9 READ (3) NC,MC,ATTACK,YAW,ACH,GAMMA,PINF,DINF,PHIO,K,Z
 A   ,NGAS,NTEST,RRX
 1   ,FN,FY,FA,MX,MY,MZ,FNZ,FYZ,FAZ,MXZ,MYZ,MZZ
 2    ,(PHI(M),C(M),CZ(M),CPHI(M),M=1,MC)
 3    ,((R(N,M),U(N,M),V(N,M),W(N,M),P(N,M),D(N,M),M=1,MC),N=1,NC)
```

The variables on TAPE3 are described in sec. 8 of ref. 1. We draw the user's attention to the following:

1. Pressures and densities must have dimensions consistent with subroutine RGAS; i.e., lb_f/ft^2 and $lb_f\text{-}sec^2/ft^4$, respectively. Velocities have dimensions of $(\text{pressure/density})^{1/2}$. ATTACK and YAW are in degrees but PHI(M) is in radians. All lengths are non-dimensionalized by R_o (a characteristic length). Note that R_o must be the same nondimensionalizing length as used in subroutine BODY.
2. The data points $r = R(N,M)$, $\phi = PHI(M)$ on this tape are not required to coincide with the computational points on the initial plane for the calculation. When they do not coincide REZONE must be used. It is however required that the array R(N,M) be increasing (i.e., R(N,M) < R(N+1,M) for each fixed M) and, also, the array PHI(M) be increasing (i.e., PHI(M) < PHI(M+1)).

7.2 Data Cards (Namelist)

The unformatted data input to the program from cards is contained in three data decks using NAMELIST. Tables 1, 2, and 3 below describe the variables in each NAMELIST as well as the default values for the variables not assigned in the data decks. See Appendix B for an example of the input decks needed to run the program. Note that NAMELIST requires that column 1 on all input cards be blank.

TABLE 1 - NAMELIST/INPUT1 (Input in MAIN)

```
 NAMELIST /INPUT1/ KA,ZEND,FACTOR,DZPRINT,KOUT,ZPRINT,IZONE,
1   NCNEW,MCNEW,IPC,                K1K1NEG,ISWSMO,ISWMOD,MOD1,
2   ZMOD1ON,ZMOD1OF,PHI1JD,PHI2JD,ZCFL1,ZCFL2,KCFL,KFAC,
3   NJMPKT,NJMKTS,NTARGET,TARGETZ,IERPR
4   ,ISTART,KSTART,ELIM,LCNT,IPRCFL,ISWDIF,NSGD,NSFD
```

Variable Name	Description	Default
KA	Maximum number of steps to be taken	2000
ZEND	Last Z value in the calculation	Undef.
FACTOR	Factor is the CFL factor used in computing ΔZ (c.f., Sec. 3.6, ref. 1)	.9
DZPRINT	Controls printing with respect to Z values; e.g., the flow field variables are outputted when the calculation has marched the distance DZPRINT along the Z-axis since the last time the output was triggered.	1.E06
KOUT(I) ZPRINT(I)	KOUT and ZPRINT control printing with respect to the number of steps taken. KOUT(I) is the number of steps between print outs when ZPRINT(I-1) ≤ Z ≤ ZPRINT(I). Both vectors are of dimension 5.	KOUT(I)=20 for all I ZPRINT(I)= 1.E06 for all I
IZONE	Determines whether or not to rezone. IZONE=0, no rezone; IZONE=1, rezone.	0
NCNEW	If IZONE=1 then, NCNEW is number of points desired in radial direction after rezone	Undef.
MCNEW	If IZONE=1 then, MCNEW is number of planes desired in tangential direction after rezone	Undef.

Variable Name	Description	Default
IPC	IPC determines order of X differencing (c.f., Sec. 3.2, ref. 1) IPC=1 then forward differencing is used in the predictor step and backward differencing is used in the corrector step. IPC=0 the differencing is reversed	0
K1K1NEG	If the pressure at an interior point becomes negative the conservation vector is smoothed; c.f., Sec. 4.1, ref. 1.	2
ISWSMO	The wall entropy is extrapolated for the first ISWSMO planes (zero means no extrapolation); see Sec. 4.2, ref. 1.	0
ISWMOD	Determines which version of wall boundary condition is to be used. ISWMOD=0 means MOD 0; ISWMOD = 3 means MOD 3. ISWMOD must be 0 or 3 (see Secs. 3.4 and 10.7 of ref. 1)	3
MOD1	Controls the use of second order accuracy at the wall (see, Secs. 3.4 and 10.7 of ref. 1). MOD1 = 1 means second order accuracy will be used MOD1 = 0 means no second order accuracy will be used at the wall	1
ZMOD1ON	When Z first becomes larger than ZMOD1ON, MOD1 is set to 1. It acts independently of the present value of MOD1.	1.E06

Variable Name	Description	Default
ZMOD1OF	When Z first becomes larger than ZMOD1OF, MOD1 is set to 0. It acts independently of the preset value of MOD1.	1.E06
(PHI1JD, PHI2JD)	Defines the open plane interval measured in degrees in which JUMP SUBROUTINE is NOT used (see Secs. 4.1 and 10.4 of ref. 1)	PHI1JD=0 PHI2JD=0
(ZCFL1, ZCFL2)	Defines the open Z interval in which to reduce the CFL factor (see KFAC)	ZCFL1=0 ZCFL2=0
KCFL	Determines the number of steps after an expansion discontinuity in which to reduce the CFL factor (see KFAC) (see Sec. 4.1, ref. 1) KCFL independently of (ZCFL1,ZCFL2)	0
KFAC	When the CFL factor is reduced, KFAC is the factor by which it is reduced, i.e., FACTOR/KFAC becomes the new CFL factor.	3
NJMPKT	NJMPKT is the maximum number of steps after an expansion discontinuity for which X derivatives at the wall are modified (see Sec. 4.1, ref. 1)	0
NJMKTS	NJMKTS is the max. number of steps after a compression discontinuity for which the X derivatives at the wall are modified (see Sec. 4.1, ref. 1)	4
NTARGET	NTARGET is the number of Z target points, (Z values for which printout is desired, see sec. 8). There may be as many as 100 target points.	0
TARGETZ	The array of Z target points.	Undef.
IERRPR	In the event of an error the last IERRPR steps will be printed. If IERRPR < 0, then no printout if an error occurs (see Sec. 12.4, ref. 1).	-1
ISTART	ISTART=0 means do not restart from TAPE15 ISTART=1 means restart from TAPE15 (see, Sec. IX).	0
KSTART	If ISTART=1 then KSTART is the step number to restart from TAPE15	0

Variable Name	Description	Default
ELIM	The error tolerance used in the iterative procedures for real gas calculations	.001
LCNT	Maximum number of iterations for real gas iterative procedures	20
IPRCFL	Number of steps between printouts of CFL information	1
ISWDIF	If ISWDIF=1, the x differencing is switched from step to step. If ISWDIF=0, the x differencing is <u>not</u> switched from step to step	0
NSGD	Number of ϕ values to be inputed in subroutine TRANGD (see sec. 10)	0
NSFD	Number of $\bar{x}$ values to be inputed in subroutine TRANFD (see sec. 10)	0

Note: Where applicable all quantities referring to axial locations are measured from the nose tip.

TABLE 2 - NAMELIST/BODYRD (Input in BODYR, an entry point of BODY)

```
 NAMELIST/BODYRD/NCONE,IRND,IEFL,ACONE,ZCONE,ZRND,RRND,ZFLARE,
1 THETAFL,THETAGL,NW,NS,NL,IFW,IFS,IFL,ZW,ZS,ZL,THETAW,THETAS
2  ,PHIS,THETAL,HFW,HFS,HFL,ZFW,ZFS,ZFL,FAW,FAS,FAL
3   ,IBN,THETABN,ALNS,XLV,DELII,CENUF
```

Variable Name	Description	Default
NCONE	Number of cone sections, NCONE $\leq$ 8	1
IRND	IRND=1, if rear of the body is rounded; IRND=0, if rear is not rounded (see Fig. 2b)	0
IEFL	IEFL=1, if rear of the body has elliptical flare; IEFL=0, if it does not (see Fig. 2c)	0
ACONE(I)	Angle in degrees of cone section I, see Fig. 2a (I $\leq$ 8)	Undef. for all I
ZCONE(I)	Z value at end of I-th cone section, see Fig. 2a (I $\leq$ 8)	Undef. I < NCONE 1.E08, I = NCONE
ZRND	If IRND=1, then ZRND is the Z value where rounding begins (see, Fig. 2b)	1.E08
RRND	If IRND=1, then RRND is the radius of the round (see Fig. 2b)	Undef.
ZFLARE	If IEFL=1, then ZFLARE is Z value where the flare begins (see Fig. 2c)	1.E08
THETAFL, THETAGL	If IEFL=1, THETAFL is the angle (in degrees) of growth of the (ϕ = 0°, 180°) axis and THETAGL is the angle (in degrees) of growth of the (ϕ = 90°, 270°) axis (see, Fig. 2c)	both undef.
NW,NS,NL	The number of sections in the wind, side, and lee cut sequences, respectively. Note that NW,NS, and NS $\leq$ 4	0,0,0
IFW	IFW=1, if there is a flap on second section of wind cut sequence; IFW=0, if not.	0
IFS	IFS=1, if there is a flap on second section of side cut sequence; IFS=0, if not	0
IFL	IFL=1, if there is a flap on second section of lee cut sequence; IFL=0, if not	0

Variable Name	Description	Default
ZW(I),ZS(I), ZL(I)	Z locations of beginning of I-th section for wind, side, and lee cut sequences, respectively. ($I \leq 4$) (see Fig. 2d)	all undef.
THETAW(I), THETAS(I), THETAL(I)	Angles in degrees of I-th cut section for wind, side, and lee cut sequences, respectively. ($I \leq 4$) (see Fig. 2d)	all undef.
PHIS	Angle ϕ^*, in degrees, normal to side cut sequence (see Fig. 2d)	90.
HFW,HFS,HFL	Half-width of wind, side, and lee flaps, respectively (see Fig. 2d)	all undef.
ZFW,ZFS,ZFL	Lengths of wind, side, and lee flaps, respectively along the Z axis (see Fig. 2d)	all undef.
FAW,FAS,FAL	The angle, in degrees, of deflection, for wind, side, and lee flaps respectively (see Fig. 2d)	0,0,0
IBN	IBN=0, spherical nose section IBN=1, bent sphere-cone nose	0
THETABN	Bend angle (see Fig. 2e)	Undef.
XLV	Bent nose length (see Fig. 2e)	Undef.
DELII	Parameter used for restarting on bent nose (see sec. 11)	0
CENUF	Parameter used to test for axis shift in bent nose calc. (see sec. 11)	.5

Note 1: It is not necessary to set undefined variables if they are not used. For instance, if NS=0, THETAS and ZS may be left undefined.

Note 2: All angles are in degrees. The convention used for determining whether an angle is positive or negative is: if it increases the body radius with increasing Z it is positive. If it decreases the body radius with increasing Z it is negative.

Note 3: Cut sequences must begin before the beginning of a rounding or of an elliptic flare. Also, the body cannot be both flared and rounded.

Note 4: All length dimension in this routine are nondimensionalized by the nose radius.

TABLE 3 - NAMELIST/OUTRD (Input in OUT)
NAMELIST/OUTRD/ZREF,AREF,ZC,ZO,IPCID

Variable Name	Description	Default
ZREF	Reference length used in defining moment coefficients (see Sec. 8 and Fig. 3). Note, ZREF is non-dimensionalized by R_o	ZEND+ZO
AREF	Reference area used in definitions of force and moment coefficients; non-dimensionalized by R_o^2 (see Sec. 8 and Fig. 3)	base area of the uncut, unrounded, unflared body at z=ZEND
ZC	Z location of the moment center, non-dimensionalized by R_o (see, Sec. 8 and Fig. 3)	0.
ZO	User selected origin for outputing surface pressure and aerodynamic coefficients (see Sec. 8 and Fig. 3)	0.
IPCID	IPCID=0, the surface pressure ratio is printed IPCID=1, the surface pressure coefficient is printed (see Sec. 8)	0

7.3 <u>Data Cards (Formatted)</u>: When the user chooses to use a nonuniform spatial mesh by specifying the discrete spatial points (c.f., sec. 10), the required data is read from cards in a formatted form.

If a nonuniform spacing in the ϕ direction is to be used, NSGD is the number of points in the ϕ direction (see sec. 7.2). The values of $\phi(M)$=PHI(M) for M=1,2,··,NSGD in degrees are read with FORMAT(5F10.0) in subroutine TRANGD. Note that PHI(1)=0° and PHI(NSGD)=180° or 360° depending on whether the symmetric or nonsymmetric problem is being considered.

If a nonuniform spacing in the normalized r coordinate, $\overline{x} = (r-b)/(c-b)$, is to be used, NSFD is the number of points in the r direction (see sec. 7.2). The values of $\overline{x}(N)$ for N=1,2,···,NSFD are read with FORMAT(5F10.0) in subroutine TRANFD. Note that $\overline{x}(1)=0$ (the body) and $\overline{x}(NSFD)=1$ (the bow shock).

8. OUTPUT

8.1 TAPE OUTPUT: The program generates two unformatted tapes. The "WRITE" statements for both these tapes are the same, variable for variable, as the READ(3) statement given in section 7.1. The output tapes are:

1.) TAPE17 - This tape is written for the last computational step before a normal program stop. It is used to restart the calculation.

2.) TAPE16 - This tape is written for every computational step in the run. It is read in subroutine OUT to print out surface pressure distributions and force and moment coefficients. The user may use this tape to interface with other programs such as plotting routines. This tape can also be used for restarting after an error mode termination of the program (see Section 9).

8.2 Printed Output: The printed output generated by the program is in four sections. Example printouts are given in Appendix B.

Section 1 - This section of printout is the heading page (3 copies are printed). The heading page describes the particular run to be made, the body being used, and the various options selected for the calculation.

Section 2 - In this section of output the flow field data is printed at the axial locations specified by the input parameters DZPRINT, KOUT, ZPRINT, and TARGETZ (see Table 1 of Sec. 7.2) Also in this section comments and data associated with the step size determination and various special procedures are printed out

throughout the calculation. If an error mode termination occurs, this section contains the flow field data for the last IERRPR steps when RECOVR is used. The flow field data printed in this section contains the following for each value of the coordinate ϕ at the fixed axial station (note that ϕ is referred to as ANGLE in the printout):

Z	axial location from nose tip
B	radius of body
BZ,BPHI	derivatives of body radius with respect to z and ϕ, respectively
C	radius of the bow shock
CZ,CPHI	derivatives of the shock radius with respect to z and ϕ, respectively
R	radial coordinate
W,U,V	the velocity components in the z, r, and ϕ directions, respectively (ft/sec)
P	pressure (lb_f/ft^2)
RHO	density $((lb_f\text{-}sec^2)/ft^4)$
S	entropy, free stream entropy is zero $(ft^2/(sec^2\text{-}°R))$
M	Mach number
GAMMA	effective gamma = $\rho h/(\rho h-p)$, Γ in Ref. 1

Note: Where applicable, all quantities are nondimensionalized as indicated in Sec. 7.1.

Section 3 - In this section of output, either the surface pressure ratio, p/p_∞, (when IPCID=0) or the surface pressure coefficient, $2(p-p_\infty)/\rho_\infty V_\infty^2$,

(when IPCID=1) are printed as a function of $\xi = z + z^{(0)}$ and ϕ where $z^{(0)}$ = ZO is the user supplied origin (see Fig. 3). In this section, there is print out for every computational point on the body surface.

Section 4 - The aerodynamic data is printed in two parts, the first of which contains the static stability coefficients shown in Figure 3. Here CN, CA and CY represent the normal, axial and side force coefficients while CMN, CMM and CML stand for the pitch, yaw and roll moment coefficients taken about $x = 0$, $y = 0$, $z = z_c$. The variable, XCPP and XCPY are the centers of pressure in the pitch and yaw planes respectively, measured from the origin $0^{(0)}$ and normalized by reference length, z_{ref} (see Figure 3). The printed force and moment coefficients are defined by:

$$\text{force coeff} = (\text{force})/q\, A_{ref}$$

$$\text{moment coeff} = (\text{moment})/q\, A_{ref}\, z_{ref}$$

Here $q = \frac{1}{2}\rho_\infty V_\infty^2$ and A_{ref} and z_{ref} are supplied by the user in NAMELIST OUTRD. The above quantities are printed at ZEND and the axial locations specified by TARGETZ. In the print out, the axial location are referred to the origin $0^{(0)}$, see Fig. 3.

In the second part of this section, the z derivatives of the force and moment coefficients are printed as a function of $\xi = z + z^{(0)}$ for every axial step in the calculation. The notation in this second part follows that of the first part; e.g., $CNZ = \frac{\partial CN}{\partial z}$, etc.

IMPORTANT NOTE: The user selected origin is used only in the printout of the aerodynamic data. The code always operates in the coordinate system with origin at 0 (see Fig. 3). Therefore, the body geometry and all program controls must be referred to the origin 0.

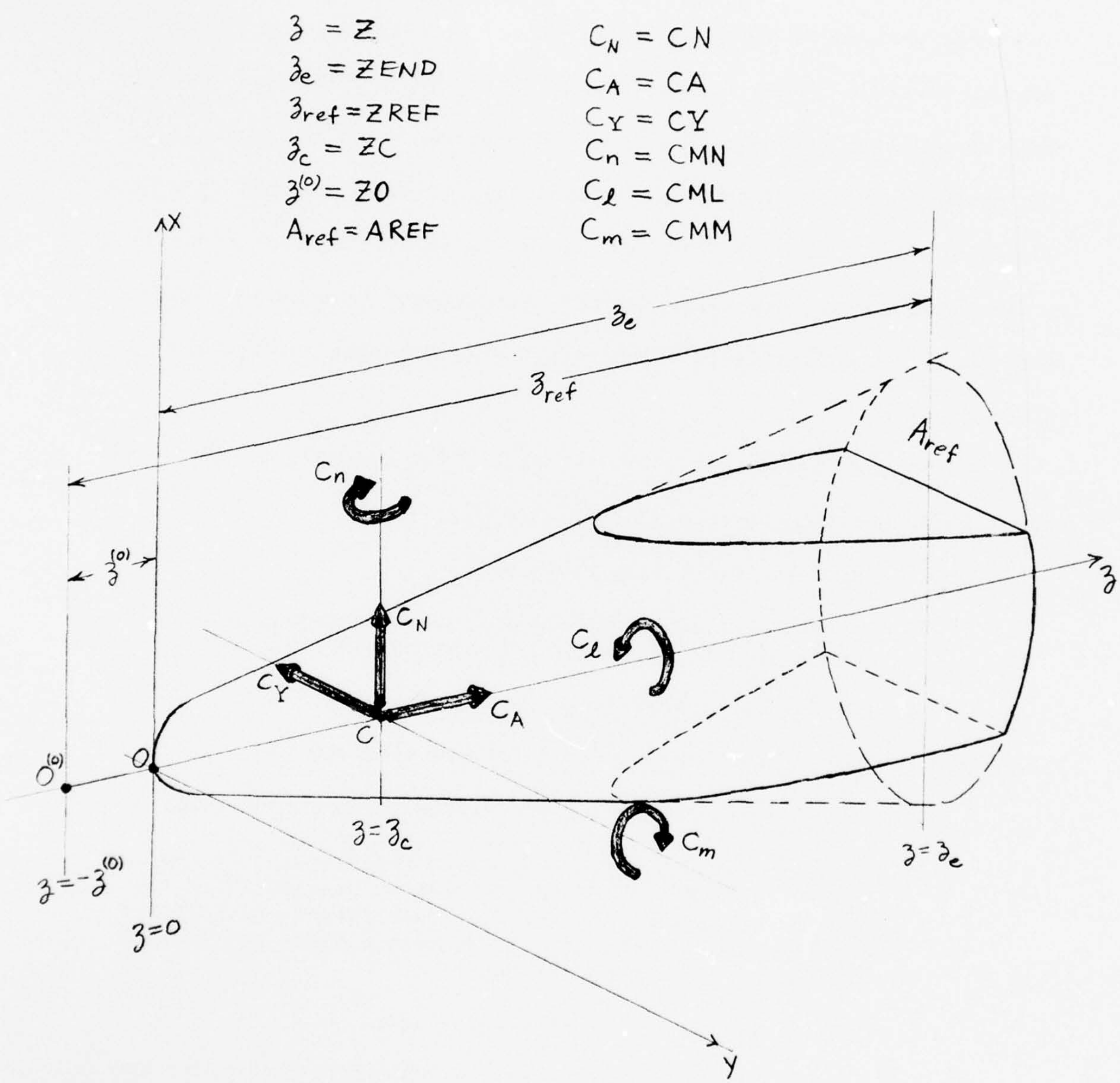


Fig. 3, Sign Conventions and Notation Used in Force and Moment Coefficients

9. RESTART AND REZONE CAPABILITIES

If desired, the program may be stopped before the end of the body and restarted and/or rezoned. This option is used, for example, to change options to handle a different characteristic of the flow. Another possible reason for restarting is to change the mesh. This is done through the rezone option (see IZONE in the input data section). The rezone operation interpolates (linearly) to determine new flow field variables; c.f., Sec. 11.3 of ref. 1. It is inadvisable to rezone after a discontinuity in body slope has been encountered because the large gradients in the flow field which result will make the interpolated data erroneous.

The program allows the user two options for restarting. The steps for the first option are as follows (see Fig. 4):

1. After the first run, save TAPE17.
2. For the next run, use TAPE17 from the previous run as the input tape, TAPE3. Again if desired, TAPE17 can be saved.
3. For further restart runs, repeat step 2.

The steps for the second option are as follows (see Fig. 5):

1. For the first run, REQUEST, TAPE16 as an output tape.
2. For the next run, use TAPE16 from the previous run as the input tape, TAPE15. Read in ISTART=1 and KSTART as the step number at which to restart (see ISTART and KSTART in the input data section). If desired, TAPE16 may again be requested as an output tape.
3. For further restart runs, repeat step 2.

The program also has provisions for the automatic restarting and rezoning required after an axis shift in bent cone calculations (see sec. 11).

Note: In bent cone calculations, the user can restart and rezone without an axis shift using the above options, however, in these cases core must be zeroed before the restart run.

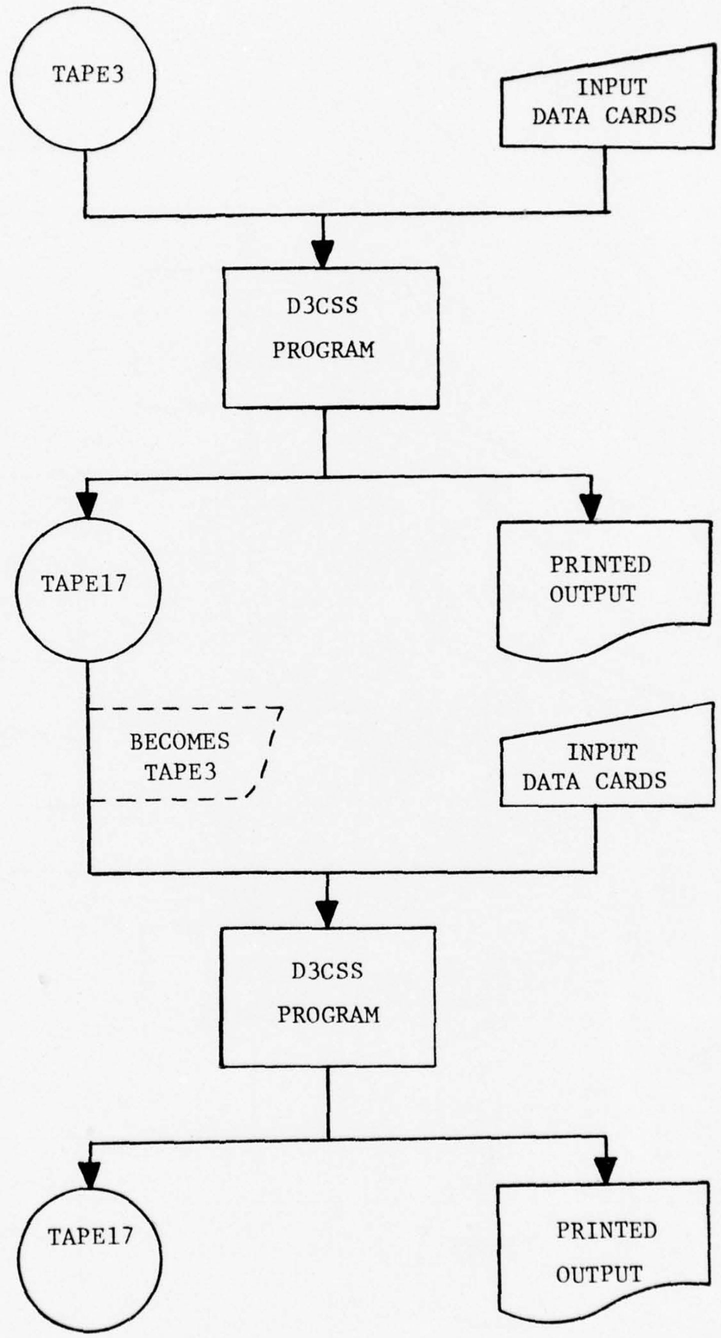


Fig. 4, Restart Using First Option

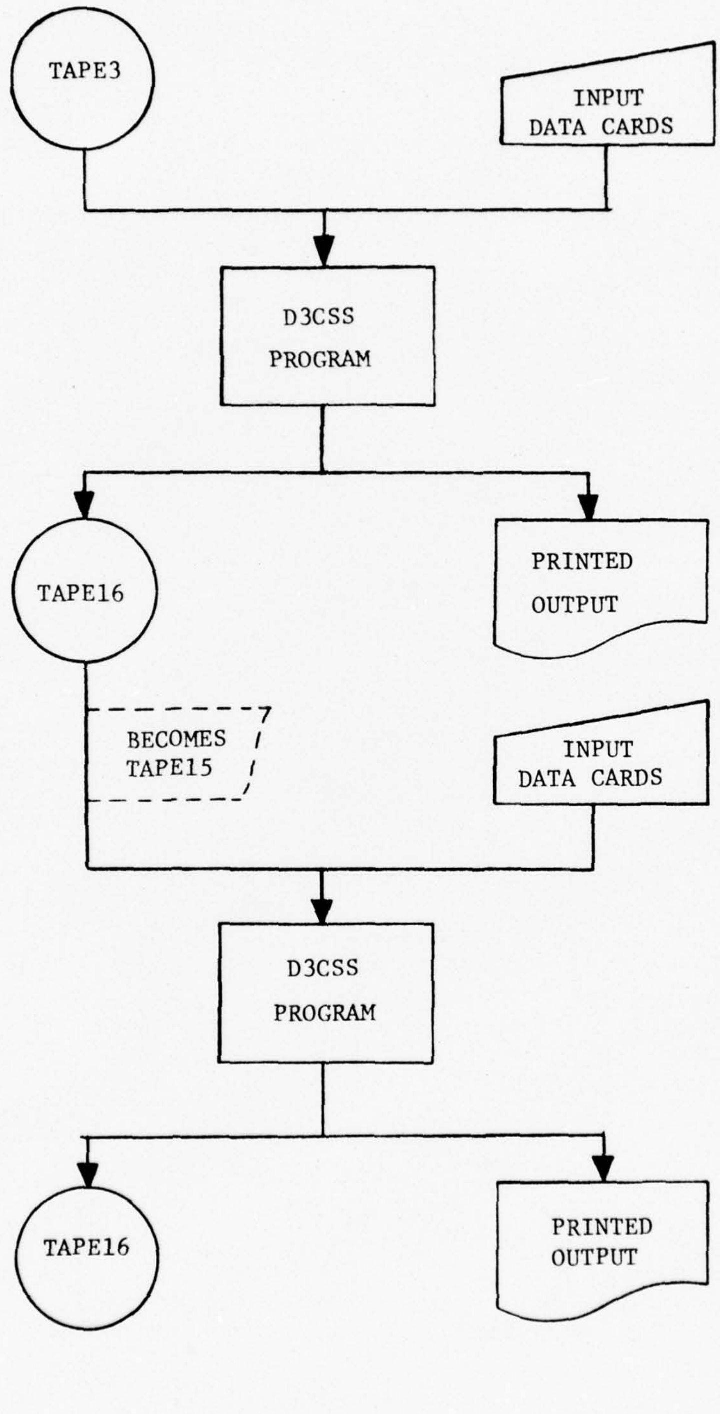


Fig. 5, Restart Using Second Option

10. MESH CLUSTERING

The program provides two methods for clustering the computational points in the shock layer in either the r or ϕ or both directions. The first uses analytic mapping functions, the other allows the user to directly input the desired mesh points in the shock layer. Both methods are discussed in section 4.3 of Ref. 1. Note that the clustering feature is contained entirely in the subroutines TRANF and TRANG (see sec. 10.5 and 10.6 of Ref. 1 for a description of these routines).

10.1 Analytic Mesh Clustering Functions: At the present time, we have not sufficiently studied the use of analytic mesh clustering functions and therefore cannot make specific recommendations. For the convenience of the user who may wish to experiment with the use of this feature, we include here instructions for incorporating mesh clustering functions into the program. The first step is to select the mapping function f(X,Y,Z) or g(Y,Z), or both, which produce the desired clustering and which are admissible. The restrictions on the functions f and g and an example are given in Sec. 4.3 of ref. 1. If the selected function f is not $f \equiv X$ then the delivery version of TRANF must be modified. If the function g selected is not $g \equiv Y$ then the delivery version of TRANG must be modified. For easy reference, listings of the delivery versions of TRANF and TRANG are given in Figures 6 and 7, respectively.

To modify TRANF, FORTRAN expressions must be written which define the following variables as functions of X(N), Y(M), and Z:

$$SX = f \ , \quad SFX = f_X \ , \quad SFY = f_Y \ , \quad SFZ = f_Z$$

$$SFXX = f_{XX} \ , \quad SFYX = f_{YX} \ , \quad SFZY = f_{ZX}$$

TRANF can then be modified using the following UPDATE IDENT:

```
*IDENT TRANF1
*DELETE TRANF.28,TRANF.29
     Insert FORTRAN cards for computing SFX,SFY, etc. which
     do not depend on X(N)
*DELETE TRANF.40
     Insert FORTRAN cards for computing SX and SFX,SFY, etc.
     which depend on X(N)
*DELETE TRANF.61
3010 FORMAT(11X,*Identification statement for new transformation
               function f*)
```

To modify TRANG, FORTRAN expressions must be written which define the following variables as functions of YY(=Y) and Z

$$SG = g \ , \quad SGY = g_Y \ , \quad SGZ = g_Z \ ,$$

$$SGYY = g_{YY} \ , \quad SGYZ = g_{YZ}$$

TRANG can be modified using the following UPDATE IDENT:

```
*IDENT TRANG1
*DELETE TRANG. 38

       SG=
       SGY=
       SGZ=       }  Expressed as functions of YY and Z
       SGYY=
       SGYZ=

*DELETE TRANG. 54
3010 FORMAT(11X,*Identification statement for new transformation g*)
```

```
      SUBROUTINE TRANF(M,J,I)
C
C       TRANF DEFINES QUANTITIES ASSOCIATED WITH THE CLUSTERING
C       TRANSFORMATION IN THE R DIRECTION (SEE STATEMENTS
C       1-8 BELOW).  THE CLUSTERING TRANSFORMATION IS ASSUMED
C       IN THE FORM
C             SX=SF(X,Y,Z)    WHERE    SX=(R-B(Z,PHI))/(C(Z,PHI)-B(Z,PHI))
C       THE USER CAN SPECIFY THE FUNCTION SF(X,Y,Z).
C       THE USER MUST DEFINE AS FUNCTIONS OF (X,Y,Z) THE FOLLOWING
C             SX, SFX, SFY, SFZ, SFXX, SFZX, SFYX
C       SEE USERS MANUAL FOR RESTRICTIONS AND INSTRUCTIONS
C       J=1,2,3 IS A LINE INDEX FOR TRANF QUANTITIES
C       I=1,2   IS A LINE INDEX FOR TRANF QUANTITIES
C
      COMMON NC,MC,K,PINF,DINF,PHIO,IDYAW,PI,RAD
      COMMON YZ(3),YPHI(3),C(25),CZ(25),CPHI(25),R(20,25)
      COMMON D(20,25),P(20,25),U(20,25),V(20,25),W(20,25),ASQ(20,25)
      COMMON CU(4,20,25),CUP(4,20,25)
C  ***   END OF BLANK COMMON   ***
      COMMON /CTRANF/ NSFD,SFD(20),SFXD(20),SFXXD(20)
      COMMON /CBODY/ Z,BZZ,BPHPHI,BZPHI,TANCO,DELZ
     1  ,PHI(25),B(25),BZ(25),BPHI(25),COSPHI(25),SINPHI(25)
      COMMON /BLK02/ THETA,DY,TG4(3),TG5(3),TG6(3)
     1    ,X(20),XZ(20,2),XR(20,2),XPHI(20,2),Y(25)
     2    ,TF4(20,2),TF6(20,2),TF7(20,2)
C
      CZM=CZ(M)      $  BM=B(M)      $    BZM=BZ(M)      $BPHIM=BPHI(M)
      CMB=C(M)-BM    $   BZMCZ=BZM - CZM  $  BPMCP=BPHIM  -CPHI(M)
      YZJ=YZ(J)      $   YPHIJ=YPHI(J)    $   TG6J=TG6(J)
C***********************************************************************
C
C       THIS ROUTINE IS VERSION 1 OF TRANF CORRESPONDING EITHER
C       TO NO CLUSTERING, I.E., SF(X,Y,Z)=X
C       OR THE USER HAS READ IN THE SF(X) DATA POINTS
C
      SFX=1.0      $   SFXX=0.0     $   SFY=0.0
      SFZX=0.0     $    SFYX=0.0     $   SFZ=0.0
      DO 100 N=1,NC
      IF (NSFD .EQ. 0) GO TO 25
C
C       THE USER READ IN THE SF(X) DATA POINTS
C
      SX=SFD(N) $ SFX=SFXD(N) $ SFXX=SFXXD(N)
      GO TO 50
C
C       CORRESPONDS TO NO CLUSTERING
C
   25 SX=X(N)
C  ***     THE FOLLOWING STATEMENTS SHOULD APPEAR IN ALL VERSIONS     ***
   50 SX1=SX-1.
      FX=1./SFX
      FTHD=-SFY*FX*YPHIJ
      FZ=-FX*(SFZ+SFY*YZJ)
    1 R(N,M)=BM+SX*CMB
    2 XR(N,I)=TXR=FX/CMB
    3 XZ(N,I)=FZ+TXR*(SX1*BZM-SX*CZM)
    4 XPHI(N,I)=FTHD+TXR*(SX1*BPHIM-SX*CPHI(M))
    5 TF4(N,I)=SFXX/SFX
    7 TF6(N,I)=TG6J +(SFZX+SFYX*YZJ)/SFX-BZMCZ/CMB
    8 TF7(N,I)=SFYX*YPHIJ/SFX-BPMCP/CMB
  100 CONTINUE
      RETURN
      ENTRY TRANFW
      IVERSON=1
      WRITE (6,3000) IVERSON
      IF (NSFD .EQ. 0) WRITE (6,3010)
      IF (NSFD .NE. 0) WRITE (6,3020)
 3000 FORMAT(1H0,20X,*PROGRAM TRANF*,6X,*VERSION*,I4)
 3010 FORMAT(11X,*EQUAL SPACING IN RADIAL DIRECTION*)
 3020 FORMAT(11X,*SF(X) WAS READ IN AS DATA POINTS*)
      RETURN
      END
```

Fig. 6. Listing of Delivery Version of TRANF

```
      SUBROUTINE TRANG(YY,M,J)
C
C       TRANG DEFINES QUANTITIES ASSOCIATED WITH THE CLUSTERING
C       TRANSFORMATION IN THE PHI DIRECTION (SEE STATEMENTS
C       1-6 BELOW).  THE CLUSTERING TRANSFORMATION IS ASSUMED
C       IN THE FORM
C              THETA=SG(YY,Z)    WHERE    THETA=PHI/PHIO
C       THE USER CAN SPECIFY THE FUNCTION SG(YY,Z)
C       THE USER MUST DEFINE AS FUNCTIONS OF (YY,Z) THE FOLLOWING
C              SG, SGY, SGZ, SGYY, SGYZ
C       SEE USERS MANUAL FOR RESTRICTIONS AND INSTRUCTIONS
C       M IS THE INDEX FOR THE TANGENTIAL PLANE
C       J=1,2,3 IS A LINE INDEX FOR TRANG QUANTITIES
C
      COMMON NC,MC,K,PINF,DINF,PHIO,IDYAW,PI,RAD
      COMMON YZ(3),YPHI(3),C(25),CZ(25),CPHI(25),R(20,25)
      COMMON D(20,25),P(20,25),U(20,25),V(20,25),W(20,25),ASQ(20,25)
      COMMON CU(4,20,25),CUP(4,20,25)
C  ***   END OF BLANK COMMON   ***
      COMMON /CTRANG/ NSGD,SGD(25),SGYD(25),SGYYD(25)
     1   ,GYMDY,GYYMDY,GY1PDY,GYY1PDY
     2   ,MCP
      COMMON /CBODY/ Z,BZZ,BPHPHI,BZPHI,TANCO,DELZ
     1   ,PHI(25),B(25),BZ(25),BPHI(25),COSPHI(25),SINPHI(25)
      COMMON /BLK02/ THETA,DY,TG4(3),TG5(3),TG6(3)
     1   ,X(20),XZ(20,2),XR(20,2),XPHI(20,2),Y(25)
     2   ,TF4(20,2),TF6(20,2),TF7(20,2)
C
C       THIS ROUTINE IS VERSION 1 OF TRANG CORRESPONDING EITHER
C       TO NO CLUSTERING, I.E., SG(YY,Z)=YY
C       OR THE USER HAS READ IN THE PHI"S
C
      IF (NSGD .EQ. 0) GO TO 50
C
C       THE USER READ IN THE PHI"S
C
      IF (M .NE. MCP) GO TO 30
      SGY=GY1PDY $ SGYY=GYY1PDY $ SGZ=SGYZ=0.
      GO TO 2
   30 IF (M .NE. 0) GO TO 35
      SGY=GYMDY $ SGYY=GYYMDY $ SGZ=SGYZ=0.
      GO TO 2
   35 SG=SGD(M) $ SGY=SGYD(M) $ SGYY=SGYYD(M) $ SGZ=SGYZ=0.
      GO TO 1
C
C       CORRESPONDS TO NO CLUSTERING
C
   50 SG=YY $ SGY=1. $ SGZ=SGYY=SGYZ=0.
C
C  ***   THE FOLLOWING STATEMENTS SHOULD APPEAR IN ALL VERSIONS   ***
    1 THETA=SG
    2 YPHI(J)=1.0/(PHIO*SGY)
    3 YZ(J)=-SGZ/SGY
    4 TG4(J)=SGY
    5 TG5(J)=SGYY/SGY
    6 TG6(J)=SGYZ/SGY
      RETURN
      ENTRY TRANGW
      IVERSON=1
      WRITE (6,3000) IVERSON
      IF (NSGD .EQ. 0) WRITE (6,3010)
      IF (NSGD .NE. 0) WRITE (6,3020)
 3000 FORMAT(1H0,20X,*PROGRAM TRANG*,6X,*VERSION*,I4)
 3010 FORMAT(11X,*EQUAL SPACING IN TANGENTIAL DIRECTION*)
 3020 FORMAT(11X,*THE PHI"S WERE READ IN BY THE USER*)
      RETURN
      END
```

Fig. 7. Listing of Delivery Version of TRANG

10.2 Input of Uneven Mesh

In this approach, the user can select an uneven mesh spacing in the ϕ, or r, or both directions by inputting to the program the mesh point coordinates. ϕ and/or $\bar{x}$ where $\bar{x}$ is the normalized radial coordinate

$$\bar{x} = \frac{r-b}{c-b}$$

(b and c are the local radius of the body and bow shock, respectively). Note that in this method, the clustering in each direction is independent of the other variable and z.

When an uneven spacing is desired in the radial direction, NSFD is read in as the total number of points in the radial mesh ($\neq 0$) (see, sec. 7.2). The values $\bar{x}(N)$ for $1 \leq N \leq$ NSFD are input from cards (c.f., sec. 7.3). Note that it is required that

$$\bar{x}(N) < \bar{x}(N+1) \quad N=1,2,\cdots,NSFD-1$$

and

$$\bar{x}(1) = 0.0, \ \bar{x}(NSFD) = 1.0.$$

If a uniform mesh in the radial direction is desired, then NSFD is read in as zero.

When an uneven spacing is desired in the ϕ direction, NSGD is read in as the total number of points in the ϕ mesh ($\neq 0$) (see, sec. 7.2). The values $\phi(M)$ (in degrees) for $1 \leq M \leq$ NSGD are input from cards (c.f., sec. 7.5). Note that it is required that

$$\phi(M) < \phi(M+1), \ M=1,2,\cdots,NSGD$$

and

$$\phi(1) = 0.0$$

$$\phi(\text{NSGD}) = \begin{cases} 180.0, \text{ for the symmetric case (PHIO}=\pi) \\ 360.0, \text{ for the nonsymmetric case (PHIO}=2\pi). \end{cases}$$

Further, for the nonsymmetric case it is also required that

$$\phi(\text{NSGD-1}) = 360. - \phi(2).$$

Our experience has shown that in order to obtain accurate results using this method, the data points must, in addition to the above restrictions, have a certain degree of smoothness. We have found that good results are obtained when the numerical second differences of the data are "smooth". The selection of mesh points is primarily by trial and error. We have found that a workable approach is to use a reasonable "eyeball" choice to begin with and then smooth the data using a "mesh-preprocessor" (see Appendix A). Generally the preprocessor must be used several times before the desired smoothness is obtained. This procedure alters the initial mesh array but even after several smoothing operations the final mesh will retain the concentrations in regions where originally desired.

11. BENT CONE CALCULATIONS

11.1 Applicable Body Shapes: The computational approach used in the program is applicable to a family of body shapes depicted in Fig. 8. The body shape is required to satisfy the following restrictions:

(i.) The complete body shape must be continuous; however, discontinuities in slopes and/or curvature are allowed.

(ii.) In the bent cone section, the body must be a spherically blunted right circular cone with respect to the bend axis.

(iii.) The body shape in the transition and aft-body sections can be arbitrary but <u>must</u> be given with respect to the aft-body axis with origin as indicated in Fig. 8.

(iv.) $z_2 < z_{en} \leq \bar{z}$ (see Fig. 8)

The parameters θ_b = THETABN, α_n = ALNS, z_{en} = ZEN, r_n = RN, $\bar{z}$ = ZBAR, H_n = HN (c.f., Fig. 8) are used internally in the code. They must be defined (in ENTRY BODYR, see sec. 12.1 of Ref. 1) either by direct input or in terms of other input parameters. Note that the bent nose section geometry given in the delivery version of BODY is a special case of the above.

11.2 <u>Computational Method</u> - The general approach used for bent nose calculations is to perform the computation along various Z-axes (see Fig. 9). Each Z axis is parallel to the aft-body axis; the first is the axis through the center of the spherical tip. In the course of the calculation in the bent cone region, the axis is shifted down automatically when required. The rezoning required when the axis is shifted is done in subroutines SHFAX and SAFAXD (see sec. 11.7 of Ref. 1). The user can control the shifting of the axes by certain input parameters (see the next paragraph for details). Note, that the axis is <u>always</u> shifted to the aft-body axis <u>before</u> the calculation enters the transition region.

11.3 <u>Use</u>: When a bent cone calculation is to be performed the input variable IBN (see sec. 7.2) must be read in as one (1). The user

must supply the body geometry consistent with section 11.1, above, in BODY and BODYR. The calculation proceeds automatically; however, the user can control the Z axis shifting using the input variable CENUF (see sec. 7.2). The Z axis is shifted when either of the following criteria are met:

(i.) the z axis becomes closer than CENUF to the body (see Fig. 9)

(ii.) the axial location is within 0.5 of ZEN (see Fig. 9).

In case (i), the axis is shifted down by the amount ZMAXS = CENUF*TAN(THETABN) but never past the aft-body axis. In case (i), the axis is shifted to the aft-body axis.

Note 1: When starting the calculation from spherical blunt body data, care should be exercised so that the starting value of Z (i.e., the initial plane) should not exceed 1.-SIN(THETABN+ALNS).

Note 2: The calculation can be restarted in the bent cone region but Δ_{II} = DELII (see Fig. 9) must be inputted (see sec. 7.2).

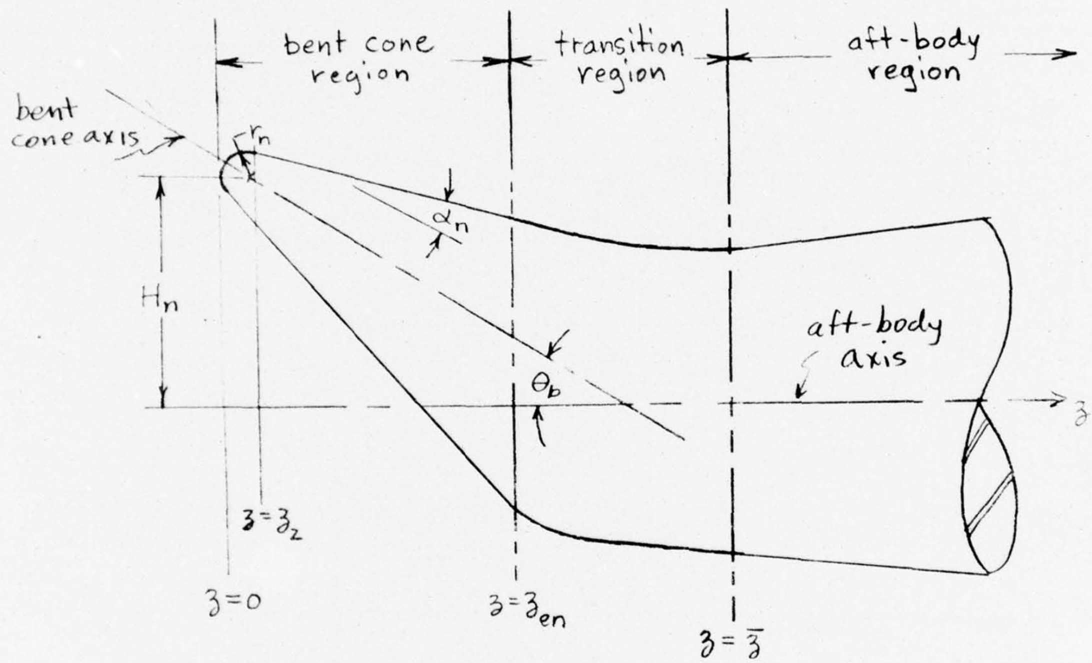


Fig. 8, Bent Cone Configuration

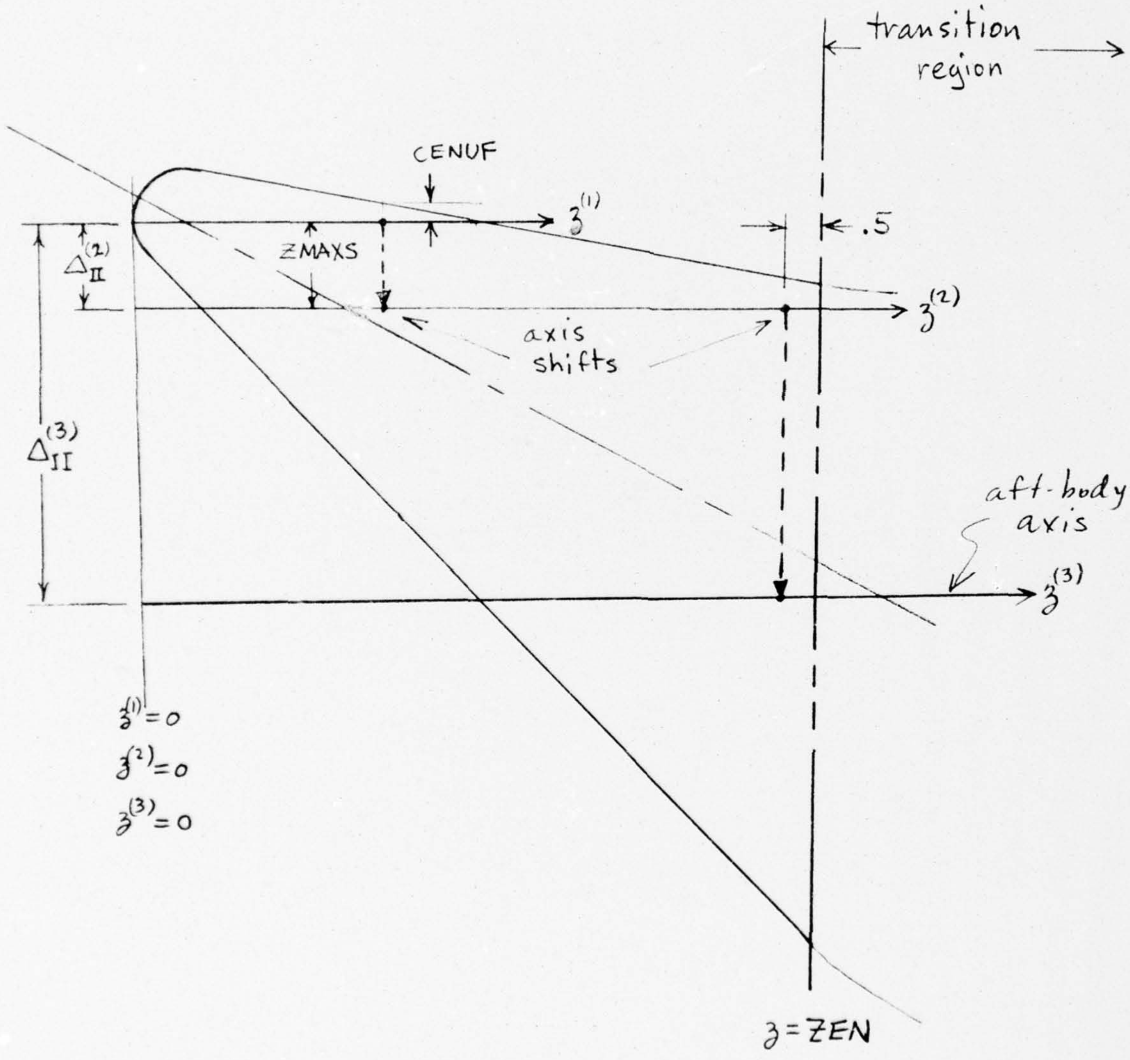


Fig. 9, Axis Shifting in Bent Cone Region

12. PROGRAM STOPS

The normal termination of the program is when either $z \geq$ ZEND or $K \geq$ KA. The program can be prematurely terminated either by programmed stops or by error mode.

12.1 Programmed Stops: The various programmed stops in the code are listed below according to the on-line printed message.

(1) NO DATA ON TAPE3---STOP---

(2) THE LAST K ON TAPE15 IS (value of K) LESS THAN (value of KSTART)

Stops 1 and 2 indicate that the wrong input tape is being used.

(3) DZ IS LESS THAN 1.E-4---STOP---

This stop is caused by the step size becoming to small. Generally, it indicates that the axial flow component is approaching the sonic value.

(4) IN SUBROUTINE SHOCK C1 = (value of C1) L,M,K = (values of L,M,K)

This message is printed in subroutine SHOCK when a change of sign in C_1 (see sec. 3.3, ref. 1) has been detected. Generally, it indicates either subsonic axial flow behind the bow shock or an unrealistic bow shock (c.f. Appendix A, ref. 1). Here L = 0 or 1 depending on whether the calculation is in the predictor or corrector step, respectively.

(5) ITERATION LIMIT EXCEEDED

(6) LIMIT ON SHOCK ITERATIONS EXCEEDED

Stops 5 and 6 are executed from subroutine DECODE when the real gas decoding procedure requires more than LCNT iterations (5 is printed when this occurs at an interior point; 6 when this occurs at a bow shock point).

(7) OBLIQUE SHOCK ITERATION EXCEEDS LIMIT

This message is printed in subroutine JUMP when the real gas iterations for the oblique shock exceeds 2*LCNT.

(8) "EXIT CALLED ON TENTH FAILURE"

This message is printed in subroutine RGAS after the thermodynamic properties are out of range 10 times (real gas calculations only).

(9) OUTSIDE GAS TABLES

This message is printed in subroutine HRGAS when the thermodynamic properties are out of range (real gas only).

Note: When the messages 3 or 4 are printed, the program executes subroutine SAVE (see sec. 12.4, ref. 1) before the run is terminated (this does not require inclusion of the system routine RECOVR). Therefore, the flow field is printed for the last |IERRPR| steps before the stop. Also, the wall pressure and aerodynamic data are printed.

12.2 Error Mode: At various locations in the code, errors can cause the program to terminate. These errors can be located using the system's error message and dump. Many times the cause of the error can be determined using the printout obtained from the recovery routine RECOVR.

A program update is available which provides, for the more common occurring errors, programmed stops consisting of an error message and a call to SAVE (without RECOVR, see the note in the previous subsection) before terminating the program. This update is given in Fig. 10. Most of the stops created by the update are caused by a negative argument in SQRT. In these cases, the error messages are of the same general form; i.e., IN ROUTINE (subr. name) AT CALL NO. (test no. within the subr.) NEGATIVE SQRT ROOT of (value of argument) FOR Z,K,M,N (value of z) (station no.) (Y mesh index) (X mesh index). The stops with this message are:

```
*IDENT DUMP
*INSERT D3CSS.165
      IERRPR=IABS(IERRPR)
*BEFORE EVAL.54
      IF (DUM1 .GE. 0.) GO TO 1001
      CALL DMPSQRT(4HEVAL,1,Z,K,M,N,DUM1)
 1001 CONTINUE
*BEFORE DECODE.21
      IF (CV(1,1,M) .GT. -600. .AND. CV(1,1,M) .LT. 700.) GO TO 2001
      WRITE (6,3456) M,CV(1,1,M)
 3456 FORMAT(1H1,*IN SUBROUTINE DECODE THE LOG OF PRESSURE ON PLANE*,I3,
     1  * ON THE BODY IS*,1PE15.6,5X,*---  STOP  ---*)
      CALL SAVE(DUM,DUM,DUM)
 2001 CONTINUE
*BEFORE DECODE.59
      IF (NTEST .LT. 0) CALL SAVE(DUM,DUM,DUM)
*DELETE DECODE.26
      CDUMP=QSQ*T3-U3*U3
      IF (CDUMP .GE. 0.) GO TO 1001
      CALL DMPSQRT(6HDECODE,1,Z,K,M,1,CDUMP)
 1001 WM=SQRT(CDUMP)/A2(J)
*DELETE DECODE.79
      CDUMP=1.-CRAP2
      IF (CDUMP .GE. 0.) GO TO 1002
      CALL DMPSQRT(6HDECODE,2,Z,K,M,N,CDUMP)
 1002 CRAP3=CRAP2/((1.+SQRT(CDUMP))*GFF)
*DELETE DECODE.173,DECODE.174
   48 CDUMP=CVN2*(CVN2*DINF2+PINF*DINF*(2.+8.*GE*GD/GIM1))
     1      +PINF*PINF*GAMMA*GAMMA
      IF (CDUMP .GE. 0.) GO TO 1003
      CALL DMPSQRT(6HDECODE,3,Z,K,M,NC,CDUMP)
 1003 PNM=(PINF+DINF*CVN2+SQRT(CDUMP))/(2.*GE)
*DELETE DECODE.192
      CDUMP=CVN2/CVTN
      IF (CDUMP .GE. 0.) GO TO 1004
      CALL DMPSQRT(6HDECODE,4,Z,K,M,NC,CDUMP)
 1004 DNM=DINF*SQRT(CDUMP)
*DELETE DECODE.216
      CDUMP=CVN2/CVT2
      IF (CDUMP .GE. 0.) GO TO 1005
      CALL DMPSQRT(6HDECODE,5,Z,K,M,NC,CDUMP)
 1005 DNM=DINF*SQRT(CDUMP)
*DELETE WALL.40
      CDUMP=(ETA*(1.+BPHOB**2)+(WW*BZM)**2)/ASQW
      IF (CDUMP .GE. 0.) GO TO 1001
      CALL DMPSQRT(4HWALL,1,Z,K,M,1,CDUMP)
 1001 BETA=SQRT(CDUMP)
*DELETE SHOCK.20
      UV=US-CPHIC*VS
      CDUMP=(ETA*CMU1+UV**2)/ASQS
      IF (CDUMP .GE. 0.) GO TO 1001
      CALL DMPSQRT(5HSHOCK,1,Z,K,M,NC,CDUMP)
 1001 BETT=SQRT(CDUMP)
*ADDFILE.
*DECK DMPSQRT
      SUBROUTINE DMPSQRT(NAME,KNT,Z,K,M,N,VALUE)
C
C       NAME IS THE NAME OF THE ROUTINE
C       KNT IS THE NUMBER FROM WHICH NAME WAS CALLED
C       Z IS THE Z VALUE
C       K IS THE STATION NO.
C       M IS THE PLANE NO.
C       N IS THE RADIAL POINT NO.
C       VALUE IS THE ARGUMENT OF SQRT ROOT
C
      WRITE (6,3000) NAME,KNT,VALUE,Z,K,M,N
 3000 FORMAT(1H1,*IN ROUTINE *,A10,* AT CALL NO.*,I3,2X,
     1   *NEGATIVE SQRT ROOT OF*,1PE15.6,
     2   * FOR Z,K,M,N*,1PE15.6,3I5)
      CALL SAVE(DUM,DUM,DUM)
      STOP
      END
```

Fig. 10. Listing of the Error-Mode Update

Routine	Call No.	Description
EVAL	1	in evaluation of stability condition (c.f. sec. 3.6, ref. 1), indicates subsonic axial flow or neg. sound speed.
DECODE	1	in eq. for axial velocity component at body surface (see, sec. 3.4, ref. 1), indicates unrealistic surface flow
DECODE	2	in decoding formula for interior pts. (see sec. 3.2, ref. 1), indicates subsonic axial flow
DECODE	3	in eq. for pressure at bow shock wave (see sec. 3.3, ref. 1), can only occur in a real gas run
DECODE	4&5	in real gas iteration formulas at bow shock wave
WALL	1	in eq. for β_1 (see sec. 3.4, ref. 1), indicates subsonic axial flow at body surface
SHOCK	1	in eq. for β_0 (see sec. 3.3, ref. 1), indicates subsonic axial flow at bow shock wave

Two additional stops are created by the update. For one the following message is printed:

IN SUBROUTINE DECODE THE LOG OF PRESSURE ON PLANE (Y index) ON THE BODY IS (value of log of pressure)---STOP---

This message is printed in DECODE when the value of the log of the surface pressure is out of the range of EXP. The other stop, also executed in DECODE, can occur only in a real gas calculation. The printed message is

P STAYS NEGATIVE AFTER AVERAGING Z,N,M,K (value of z) (X mesh index) (Y mesh index) (station no.)

Note that this message can appear in a perfect gas calculation but the program is not terminated.

12.3 Remark:

When the program terminates prematurely it generally means that either an error has been committed in setting up the run or a nonuniformity has developed in the flow field which the present method can not properly resolve. In either case, inaccurate or non-physical results are present which ultimately produce the error mode or programmed stop. Keep in mind, however, that it is possible that an accurate and physically consistent calculation can still be prematurely terminated. Obviously, there are body shapes and free stream conditions for which the flow field will violate the basic assumptions of the code; viz., that the flow is supersonic in the axial direction and moreover, that it remains attached to the body surface. On the other hand, it should by now be clear that not every calculation can be considered accurate and physically realistic simply because no premature termination occurs. All results, particularly those for new classes of body shapes, should be carefully studied for physical consistency. Good luck!

APPENDIX A

Mesh Smoothing Preprocessor

Identification: DIFF

Important Note: DIFF calls two subroutines TRANGD and TRANFD. These routines bear the same name as two subroutines in D3CSS because they accomplish the same thing. But note, the subroutine structures are different and thus the subroutines should be kept distinct.

Description: DIFF is a separate program which can be used to smooth the mesh coordinate data when the mesh is to be input from cards (see sec. 10.2). The program is used before the flow field calculation and can be used to smooth either ϕ mesh coordinates or $\bar{x}$ mesh coordinates. The basic smoothing operation used in DIFF is

$$(d_i)_{\text{smoothed}} = (d_{i+1} + 2d_i + d_{i-1})/4$$

where $\{d_i\}$ is the array of mesh point values (either $\phi(M)$ or $\bar{x}(N)$) supplied. The smoothing operation retains the required properties of the mesh arrays given in sec. 10.2. When $\bar{x}$ values are to be smoothed, the last value of $\bar{x}$ does not have to be unity since DIFF normalizes the $\bar{x}$ values after input. The program performs any number of such smoothing operations selected by the user.

Output: After each smoothing operation, DIFF prints on-line the mesh points ϕ_i (or $\bar{x}_i$) and the numerical approximations to the first and second derivatives of the underlying mesh clustering functions g_Y and g_{YY} (or f_X and f_{XX}) as functions of the mesh index M (or N). Also,

after the last smoothing operation, data cards are punched for use in the flow field program.

Input: Input to DIFF is via data cards.

Card No.	Format	Variable	Description
1	(I5)	N121	No. of smoothing operations desired
2	(2I5)	NXPHI	No. of PHI (or $\overline{x}$'s) to be read
		IXPHI	=0, PHI are read =1, $\overline{x}$'s are read
3	(5F10.10)	XPHI(N), N=1,NXPHI	the PHI (or $\overline{x}$)

Sample input data cards for the three typical applications of DIFF are given on page 45. These are: smoothing of ϕ for the symmetric problem, smoothing of $\overline{x}$, and smoothing of ϕ for the nonsymmetric problem, respectively.

Listings: The listings for DIFF are given on the following pages.

LISTING OF PRE-PROCESSOR PROGRAM

```
      PROGRAM DIFF(INPUT,OUTPUT,PUNCH,TAPE5=INPUT,TAPE6=OUTPUT)
C
C       THIS PROGRAM DOES 1-2-1 SMOOTHING OF DATA
C
      COMMON /CTRAN/ NXPHI,XPHI(200),SGYD(200),SGYYD(200)
     1    ,GYMDY,GYYMDY,GY1PDY,GYY1PDY
     2    ,MCP,PHIO,RAD,PI
C
C       N121 IS THE NUMBER OF 1-2-1 SMOOTHING OF DATA
C       NXPHI IS THE NUMBER OF PHI"S OR X"S TO BE READ
C       IXPHI = 0 THEN READ IN PHI"S (DEGREES)
C             = 1 THEN READ IN X"S
C
C           NOTE THAT THE X"S DO NOT HAVE TO BE READ IN
C       BETWEEN 0. AND 1. AS THEY ARE NORMALIZED
C
      PI=4.*ATAN(1.) $ RAD=PI/180.
    5 READ (5,2000) N121
      IF (EOF(5)) 999,10
   10 READ (5,2000) NXPHI,IXPHI
      READ (5,2100) (XPHI(N),N=1,NXPHI)
 2000 FORMAT(10I5)
 2100 FORMAT(5F10.0)
      PHIOD=XPHI(NXPHI) $ PHIO=PHIOD*RAD
      DO 25 N=1,NXPHI
   25 XPHI(N)=XPHI(N)/XPHI(NXPHI)
      N121P1=N121+1 $ NXPHIM1=NXPHI-1
      DO 100 I=1,N121P1
      IM1=I-1
      WRITE (6,3000) IM1
 3000 FORMAT(1H1,*THE DERIVATIVES AFTER*,I3,2X,
     1    *1-2-1 SMOOTHINGS ARE AS FOLLOWS*)
      IF (IXPHI .EQ. 0) CALL TRANGD
      IF (IXPHI .NE. 0) CALL TRANFD
      IF (I .EQ. N121P1) GO TO 125
      XPHINM1=XPHI(1)
      DO 50 N=2,NXPHIM1
      XPHIN=XPHI(N)
      XPHI(N)=(XPHINM1+2.*XPHIN+XPHI(N+1))/4.
      XPHINM1=XPHIN
   50 CONTINUE
      IF (IXPHI .NE. 0) GO TO 100
      IF (PHIO .LE. 2.*PI-1.E-6) GO TO 100
      XPHI(2)=XPHI(2)+360.-XPHI(NXPHIM1)
      XPHI(NXPHIM1)=360.-XPHI(2)
  100 CONTINUE
  125 IF (IXPHI .NE. 0) GO TO 200
      DO 150 N=1,NXPHI
  150 XPHI(N)=PHIOD*XPHI(N)
  200 PUNCH 4100, (XPHI(N),N=1,NXPHI)
 4100 FORMAT(5F10.5)
      GO TO 5
  999 STOP
      END
```

LISTING OF PRE-PROCESSOR PROGRAM (CONTINUED)

```
      SUBROUTINE TRANFD
C
C      TRANFD DEFINES QUANTITIES NEEDED BY SUBROUTINE
C      TRANF WHEN THE USER READS IN THE SF(X,Y,Z) DATA POINTS
C
      COMMON /CTRAN / NSFD,SFD(200),SFXD(200),SFXXD(200)
C
      NSFDM1=NSFD-1
      DX=1./FLOAT(NSFDM1)
      TWODX=1./(2.*DX) $ DXSQ=1./DX**2
      DO 50 N=2,NSFDM1
      SFXD(N)=(SFD(N+1)-SFD(N-1))*TWODX
   50 SFXXD(N)=(SFD(N+1)-2.*SFD(N)+SFD(N-1))*DXSQ
C
C      SFXXD IS ASSUMED LINEAR ON (0,2DX) AND (1-2DX,1)
C
      SFXXD(1)=2.*SFXXD(2)-SFXXD(3)
      SFXXD(NSFD)=2.*SFXXD(NSFDM1)-SFXXD(NSFD-2)
      SFXD(1)=SFXD(2)-.5*DX*(SFXXD(1)+SFXXD(2))
      SFXD(NSFD)=SFXD(NSFDM1)+.5*DX*(SFXXD(NSFD)+SFXXD(NSFDM1))
      WRITE (6,3300)
 3300 FORMAT(1H0,4X,*N*,15X,*SF*,17X,*SFX*,16X,*SFXX*)
      DO 125 N=1,NSFD
  125 WRITE (6,3400) N,SFD(N),SFXD(N),SFXXD(N)
 3400 FORMAT(1H ,I5,1P4E20.6)
      RETURN
      END
```

LISTING OF PRE-PROCESSOR PROGRAM (CONTINUED)

```
      SUBROUTINE TRANGD
C
C      TRANGD DEFINES QUANTITIES NEEDED BY SUBROUTINE
C      TRANG WHEN THE USER READS IN THE PHI VALUES
C
      COMMON /CTRAN / NSGD,SGD(200),SGYD(200),SGYYD(200)
     1   ,GYMDY,GYYMDY,GY1PDY,GYY1PDY
     2   ,MCP,PHIO,RAD,PI
C
      NSGDM1=NSGD-1
      DY=1./FLOAT(NSGDM1)
      TWODY=1./(2.*DY) $ DYSQ=1./DY**2
      DO 50 M=2,NSGDM1
      SGYD(M)=(SGD(M+1)-SGD(M-1))*TWODY
   50 SGYYD(M)=(SGD(M+1)-2.*SGD(M)+SGD(M-1))*DYSQ
      IF (PHIO .LE. 2.*PI-1.E-6) GO TO 75
C
C      NOTE THAT SGD(Y+1)=SGD(Y)+1  FOR NON-SYMMETRIC PROBLEM (PHIO=360)
C
      SGYD(1)=SGYD(NSGD)=(SGD(2)-SGD(NSGD-1)+1.)*TWODY
      SGYYD(1)=SGYYD(NSGD)=(SGD(2)-2.*SGD(1)+SGD(NSGD-1)-1.)*DYSQ
      GO TO 100
C
C      NOTE THAT FOR SYMMETRIC PROBLEM (PHIO=180)
C      SGYYD IS ASSUMED LINEAR ON (-DY,2DY) AND (1-2DY,1+DY)
C
   75 SGYYD(1)=2.*SGYYD(2)-SGYYD(3)
      SGYYD(NSGD)=2.*SGYYD(NSGDM1)-SGYYD(NSGD-2)
      GYYMDY=2.*SGYYD(1)-SGYYD(2)
      GYY1PDY=2.*SGYYD(NSGD)-SGYYD(NSGDM1)
      SGYD(1)=SGYD(2)-.5*DY*(SGYYD(1)+SGYYD(2))
      SGYD(NSGD)=SGYD(NSGDM1)+.5*DY*(SGYYD(NSGD)+SGYYD(NSGDM1))
      GYMDY=SGYD(2)-2.*DY*SGYYD(1)
      GY1PDY=SGYD(NSGDM1)+2.*DY*SGYYD(NSGD)
  100 WRITE (6,3300)
 3300 FORMAT(1H0,-X,*M*,15X,*PHI*,18X,*SG*,17X,*SGY*,16X,*SGYY*)
      M=0 $ WRITE (6,3350) M,GYMDY,GYYMDY
 3350 FORMAT(1H ,I5,40X,1P3E20.6)
      PHIOD=PHIO/RAD
      DO 125 M=1,NSGD
      PHIM=SGD(M)*PHIOD
  125 WRITE (6,3400) M,PHIM,SGD(M),SGYD(M),SGYYD(M)
 3400 FORMAT(1H ,I5,1P4E20.6)
      M=NSGD+1 $ WRITE (6,3350) M,GY1PDY,GYY1PDY
      RETURN
      END
```

LISTING OF DATA CARDS FOR PRE-PROCESSOR PROGRAM

```
    10               NUMBER OF 1-2-1 SMOOTHINGS
    33     0         NUMBER OF PHI"S TO READ
 0.        4.        8.        12.       16.
 20.       24.       28.       32.       36.
 40.       44.       48.       52.       56.
 60.       64.       68.       72.       76.
 80.       84.       88.       92.       96.
 100.      104.      110.      119.      132.
 148.      164.      180.
    10               NUMBER OF 1-2-1 SMOOTHINGS
    26     1         NUMBER OF X"S TO READ
 0.        1.        2.        3.        4.
 5.        6.        7.        8.        9.
 10.       12.       14.       16.       19.
 22.       26.       30.       35.       40.
 45.       50.       55.       60.       65.
 70.
    10               NUMBER OF 1-2-1 SMOOTHINGS
    65     0         NUMBER OF PHI"S TO READ
 0.        4.        8.        12.       16.
 20.       24.       28.       32.       36.
 40.       44.       48.       52.       56.
 60.       64.       68.       72.       76.
 80.       84.       88.       92.       96.
 100.      104.      110.      119.      132.
 148.      164.      180.      196.      212.
 228.      241.      250.      256.      260.
 264.      268.      272.      276.      280.
 284.      288.      292.      296.      300.
 304.      308.      312.      316.      320.
 324.      328.      332.      336.      340.
 344.      348.      352.      356.      360.
```

APPENDIX B

Sample Run

In this Appendix, a sample calculation is presented to illustrate the use of the code for a realistic reentry configuration. The body shape considered is a spherically blunted 20° - 5° biconic with a windside flat and flap (see Fig. B-1). A perfect gas is assumed with $\gamma = 1.4$. The freestream conditions are:

$M_\infty = 15$ (Mach number)

$p_\infty = 1.0\ lb_f/ft^2$ (pressure)

$\rho_\infty = 1.x10^{-5}\ (lb_f\text{-}sec^2)/ft^4$ (density)

$\alpha = 7.5°$ (angle of attack)

$\beta = 0°$ (side slip angle)

The blunt body region was determined using the program of ref. 2. The initial plane was placed at the sphere-cone juncture ($z \simeq .658$).

In setting up this particular calculation, it is desirable to use the following computational options:

i.) wall entropy reduction (c.f., sec. 4.2, ref. 1)

ii.) the Mod 3 version of the wall boundary conditions with second order accuracy (c.f. sec. 3.4 and 10.7, ref. 1)

iii.) a meridional mesh spacing of $\Delta\phi = 4°$ in the vicinity of the flat and flap but a coarser mesh elsewhere

The other parameters and options used in the calculation can be found from the enclosed input and output which follows. Note that items i.) and ii.) are subject to internal program controls when the body has discontinuous slopes as in the present example (c.f. sec. 4.1, ref. 1).

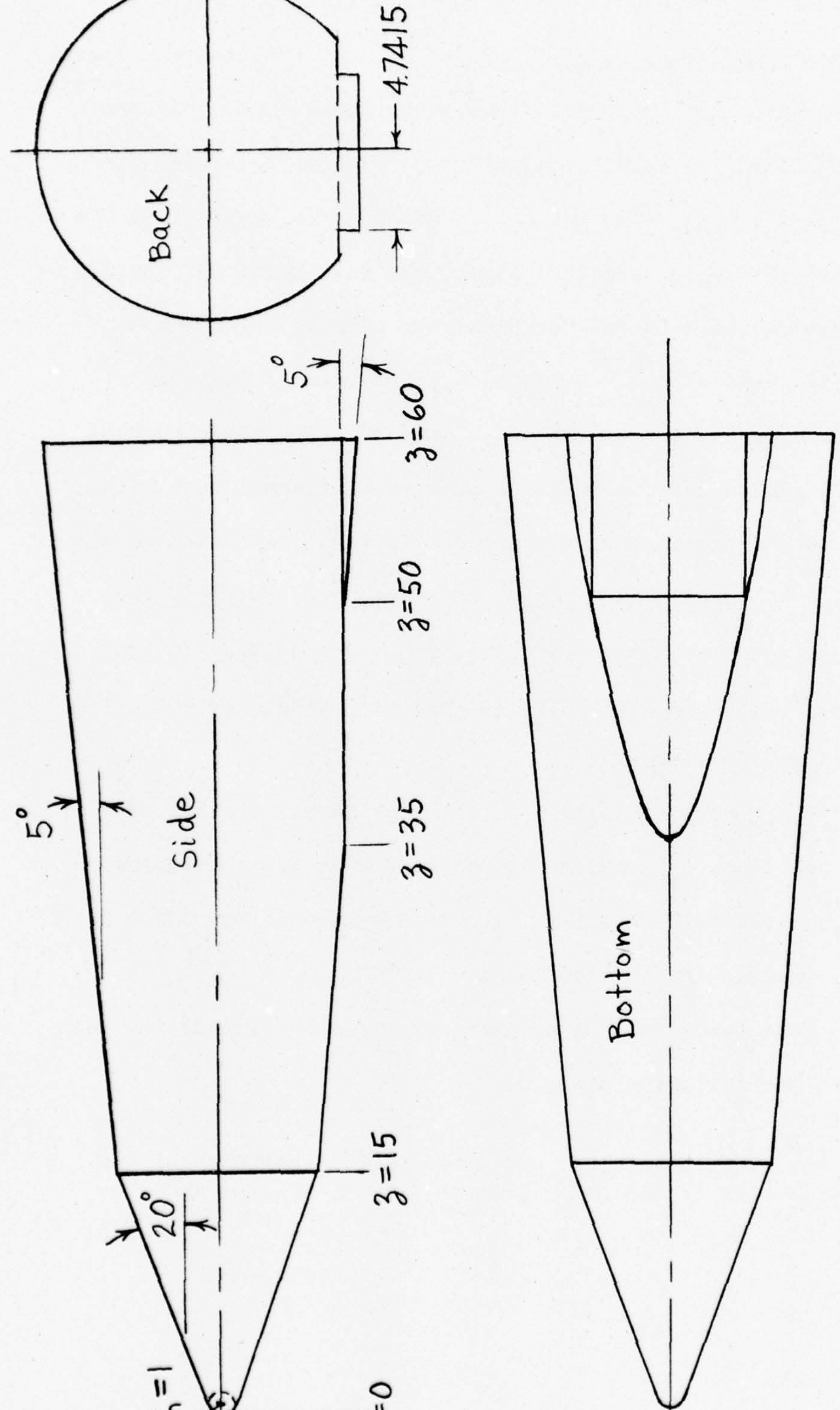


Fig. B-1, Body Geometry for Sample Run

This calculation is performed in three separate runs; viz.,

Run No. 1 (sphere-cone juncture $\leq z \leq 20^{\dagger}$): In this run, the meridional mesh is uniform with $\Delta\phi = 15°$. Note that after the biconic juncture ($z = 15$), the option ii.) is automatically modified in the code.

Run No. 2 ($20^{\dagger} \leq z \leq 33^{\dagger}$): The purpose of stopping and restarting the calculation near $z = 20$ is twofold. First, the wall point calculation procedure is changed back to the Mod 3 version with second order accuracy. It was felt that $z = 20$ is sufficiently far downstream of the biconic juncture for this to be done "safely". The other purpose is to perform a preliminary rezone to a uniform meridional mesh with $\Delta\phi = 7.5°$. This is done in anticipation of the final reduction of the mesh to $\Delta\phi = 4°$. Generally it is safer computational practice, when rezoning for a finer mesh, to perform this in stages so that in each rezone the mesh lengths in each direction are reduced by not more than one-half their previous lengths.

Run No. 3 ($33^{\dagger} \leq z \leq 60$): In this run, the mesh is rezoned for $\Delta\phi = 4°$ near the flat and flap. The meridional mesh used is nonuniform and input from data cards (c.f., sec. 10.2).. It has $\Delta\phi = 4°$ for $0 \leq \phi \leq 92°$ with a gradual increase to $\Delta\phi \simeq 16°$ at $\phi = 180°$.

The input data cards and the printed output (abbreviated) for each run are given in the following pages.

---

† Note that the run is terminated and subsequently restarted at the first marching step beyond this value of z.

SAMPLE INPUT DECK SETUP FOR D3CSS PROGRAM
RUN 1

```
N999,P5000,T032,CP70.
ACCOUNT(     FERGUSON,R.       09827 N999A655044 4270540       87000 6320 )
ATTACH(TAPE3,8M15A7P5C20P13)
ATTACH(D3CS,8D3CSN20M50)
REQUEST,TAPE17,*PF.
LDSET(PRESET=INDEF)
D3CS.
CATALOG(TAPE17,8M15A7P5C20P13Z20)
    7/8/9      END OF FILE
 $INPUT1
 ZEND=20.,
 ISWSMO=13,
 KOUT(1)=100,
 IERRPR=-1,
 $END
 $BODYRD
 NCONE=2,
 ACONE(1)=20.,ACONE(2)=5.,
 ZCONE(1)=15.,
 NW=2,
 ZW(1)=35.,ZW(2)=50.,
 THETAW(1)=0.,THETAW(2)=0.,
 IFW=1,
 ZFW=12.,
 FAW=5.,
 HFW=4.7415,
 $END
 $OUTRD
 $END
    7/8/9      END OF FILE
    6/7/8/9    END OF INFORMATION
```

```
        SAMPLE INPUT DECK SETUP FOR D3CSS PROGRAM
                   RUN 2
  RESTARTS FROM RUN 1 AND REZONES TO 25 PLANES EQUAL SPACED


N999,P5000,T032,CP70.
ACCOUNT(    FERGUSON,R.       09827 N999A655044 4270540      87000 6320 )
ATTACH(TAPE3,8M15A7P5C20P13Z20)
ATTACH(D3CS,8D3CSN20M50)
REQUEST,TAPE17,*PF.
LDSET(PRESET=INDEF)
D3CS.
CATALOG(TAPE17,8M15A7P5C5P25Z33)
    7/8/9      END OF FILE
 $INPUT1
 ZEND=33.,
 IZONE=1,NCNEW=13,MCNEW=25,
 ISWSMO=25,
 KOUT(1)=100,
 IERRPR=-1,
 $END
 $BODYRD
 NCONE=2,
 ACONE(1)=20.,ACONE(2)=5.,
 ZCONE(1)=15.,
 NW=2,
 ZW(1)=35.,ZW(2)=50.,
 THETAW(1)=0.,THETAW(2)=0.,
 IFW=1,
 ZFW=12.,
 FAW=5.,
 HFW=4.7415,
 $END
 $OUTRD
 $END
    7/8/9      END OF FILE
    6/7/8/9    END OF INFORMATION
```

SAMPLE INPUT DECK SETUP FOR D3CSS PROGRAM
RUN 3
RESTARTS FROM RUN 2 AND REZONES TO 33 PLANES THAT ARE READ

```
N999,P5000,T032,CP70.
ACCOUNT(     FERGUSON,R.        09827 N999A655044 4270540        87000 6320 )
ATTACH(TAPE3,8M15A7P5C5P25Z33)
ATTACH(D3CS,8D3CSN20M50)
REQUEST,TAPE17,*PF.
LDSET(PRESET=INDEF)
D3CS.
    7/8/9      END OF FILE
 $INPUT1
 ZEND=60.,
 NSGD=33,
 IZONE=1,NCNEW=13,MCNEW=33,
 ISWSMO=33,
 KOUT(1)=100,
 IERRPH=-1,
 $END
 $BODYRD
 NCONE=2,
 ACONE(1)=20.,ACONE(2)=5.,
 ZCONE(1)=15.,
 NW=2,
 ZW(1)=35.,ZW(2)=50.,
 THETAW(1)=0.,THETAW(2)=0.,
 IFW=1,
 ZFW=12.,
 FAW=5.,
 HFW=4.7415,
 $END
 $OUTRD
 $END
   0.00000    4.00000    8.00000   12.00000   16.00000
  20.00000   24.00000   28.00000   32.00000   36.00000
  40.00000   44.00000   48.00000   52.00000   56.00000
  60.00000   64.00000   68.00000   72.00000   76.00000
  80.00000   84.00000   88.00000   92.00000   96.03125
 100.29688  105.37500  112.20313  121.65625  133.95313
 148.43750  164.04688  180.00000
    7/8/9      END OF FILE
    6/7/8/9    END OF INFORMATION
```

```
          PROGRAM D3CSS       VERSION  10       DATE    03/21/77        TIME    18.45.40
3-D SUPERSONIC FLOW  -  FLOW IS NONSYMMETRICAL
MAXIMUM NO. OF STEPS = 2000        LAST Z VALUE =    2.000000E+01        CFL FACTOR =  .900
ERROR LIMIT    1.0000E-03  MAXIMUM NUMBER OF ITERATIONS    20
PRINT CONTROLS ARE       ZPRINT  1000000.00  1000000.00  1000000.00  1000000.00  1000000.00
                         KOUT          100          20          20          20          20
                         DZPRINT 1000000.00
MACH NO. =    15.00       ANGLE OF ATTACK =    7.50       YAW ANGLE =    0.00    VINF =    5612.49
FREE STREAM PROPERTIES , PINF =    1.0000E+00 DINF =    1.0000E-05 HINF =    3.5000E+05 HO =    1.6100E+07 SINF =    0.
PERFECT GAS    (GAMMA =  1.40     GAS CONSTANT =      1.020191E+04)
FLOW IS PERIODIC WITH PERIOD = 180.00
CALC. BEGINS AT Z =    .6579799E+00
RADIAL INTERVALS NA =  14       TANGENTIAL INTERVALS MA =  12

          PROGRAM BODY       VERSION    3
BODY IS SPHERICALLY BLUNTED AND SPHERE ENDS AT Z=    .6579799E+00    WITH B=    .9396926E+00
 AFT BODY IS A MULTIPLE CONIC WITH
     ANGLE    20.0000 UP TO     15.0000
     ANGLE     5.0000 UP TO **********
THERE IS A WIND CUT OF
     ANGLE     0.0000 BEGINNING AT    35.0000
     ANGLE     0.0000 BEGINNING AT    50.0000
        WITH A FLAP OF HALF-WIDTH     4.7415 LENGTH ALONG Z-AXIS      12.0000   AT     5.0000 DEGREES

          PROGRAM TRANG       VERSION    1
EQUAL SPACING IN TANGENTIAL DIRECTION

          PROGRAM TRANF       VERSION    1
EQUAL SPACING IN RADIAL DIRECTION




              ADDITIONAL FEATURES

BACKWARD DIFFERENCE FOR PREDICTOR STEP AND FORWARD DIFFERENCE FOR CORRECTOR STEP IN X DIRECTION

WALL ENTROPY EXTRAPOLATION FOR 13 PLANES UNTIL A COMPRESSION JUMP AND THEN NO EXTRAPOLATION

MOD 3 FOR WALL POINTS UNTIL A JUMP OCCURS AND THEN MOD 0 IS USED

SECOND ORDER ACCURACY IS USED AT WALL POINTS FOR Z LESS THAN    1.000000E+06 OR UNTIL JUMP IS CALLED

IF PRESSURE IS NEGATIVE THEN THE CONSERVATION VECTORS ARE SMOOTHED BY 1- 2-1

USING JUMP WHICH COMPUTES JUMPS CORRESPONDING TO DISCONTS. IN BZ AND/OR BPHI EXCEPT FOR THE PHI INTERVAL (    0.00,     0.00)

THE CFL FACTOR IS REDUCED TO   .300 WHEN Z IS IN THE INTERVAL (     0.00,     0.00)

USE CFL FACTOR =   .300 FOR   0 STEPS AFTER AN EXPANSION JUMP OCCURS

THE TERMS FOR X DERIVATIVES AT THE WALL ARE MODIFIED FOR
        0 STEPS AFTER AN EXPANSION JUMP AND   4 STEPS AFTER A COMPRESSION JUMP
```

MACH NO IS 1.5000000E+01 ANGLE OF ATTACK IS 7.5000000E+00 ANGLE OF SIDESLIP IS 0.

PLANE 1 ANGLE IS 0.00 DEGREES
THE AXIS IS SHIFTED UP 0.0000 UNITS

STATION 0 Z IS 6.5797986E-01 B IS 9.3969262E-01 BZ IS 3.6397023E-01 BPHI IS 0.
C IS 1.2582899E+00 CZ IS 6.5707226E-01 CPHI IS 0.

R	W	U	V	P	RHO	S	M	GAMMA
1.2503E+00	3.9035E+03	1.7953E+03	-2.0568E-12	1.1195E+02	5.7033E-05	5.8165E+04	2.5919E+00	1.4000E+00
[illegible]	3.8206E+03	1.7373E+03	-2.0161E-12	1.0675E+02	5.1236E-05	6.0780E+04	2.4575E+00	1.4000E+00
1.2128E+00	3.7393E+03	1.6800E+03	-1.9761E-12	1.0207E+02	4.6408E-05	6.3170E+04	2.3361E+00	1.4000E+00
[illegible]	3.6611E+03	1.6243E+03	-1.9376E-12	9.7816E+01	4.2374E-05	6.5330E+04	2.2280E+00	1.4000E+00
1.1473E+00	3.5882E+03	1.5711E+03	-1.9017E-12	9.3913E+01	3.8999E-05	6.7257E+04	2.1334E+00	1.4000E+00
[illegible]	3.5203E+03	1.5205E+03	-1.8685E-12	9.0281E+01	3.6122E-05	6.8988E+04	2.0500E+00	1.4000E+00
1.1217E+00	3.4574E+03	1.4724E+03	-1.8379E-12	8.6860E+01	3.3633E-05	7.0552E+04	1.9763E+00	1.4000E+00
[illegible]	3.3998E+03	1.4267E+03	-1.8101E-12	8.3598E+01	3.1452E-05	7.1969E+04	1.9114E+00	1.4000E+00
[illegible]	3.3479E+03	1.3835E+03	-1.7852E-12	8.0442E+01	2.9517E-05	7.3255E+04	1.8545E+00	1.4000E+00
[illegible]	3.3024E+03	1.3428E+03	-1.7636E-12	7.7350E+01	2.7779E-05	7.4422E+04	1.8056E+00	1.4000E+00
[illegible]	3.2637E+03	1.3043E+03	-1.7456E-12	7.4272E+01	2.6195E-05	7.5483E+04	1.7640E+00	1.4000E+00
[illegible]	3.2325E+03	1.2677E+03	-1.7314E-12	7.1161E+01	2.4729E-05	7.6448E+04	1.7299E+00	1.4000E+00
9.8521E-01	3.2101E+03	1.2325E+03	-1.7216E-12	6.7966E+01	2.3349E-05	7.7327E+04	1.7033E+00	1.4000E+00
9.6245E-01	3.1974E+03	1.1980E+03	-1.7165E-12	6.4622E+01	2.2021E-05	7.8130E+04	1.6846E+00	1.4000E+00
[illegible]	3.1962E+03	1.1633E+03	-1.7169E-12	6.1074E+01	2.0722E-05	7.8861E+04	1.6744E+00	1.4000E+00

PLANE 2 ANGLE IS 15.00 DEGREES
THE AXIS IS SHIFTED UP 0.0000 UNITS

STATION 0 Z IS 6.5797986E-01 B IS 9.3969262E-01 BZ IS 3.6397023E-01 BPHI IS 0.
C IS 1.2605553E+00 CZ IS 6.5982145E-01 CPHI IS 1.7283177E-02

R	W	U	V	P	RHO	S	M	GAMMA
1.2606E+00	3.9037E+03	1.8094E+03	1.5510E+02	1.1129E+02	5.7016E-05	5.8025E+04	2.6045E+00	1.4000E+00
1.2376E+00	3.8213E+03	1.7507E+03	1.5204E+02	1.0606E+02	5.1169E-05	6.0662E+04	2.4690E+00	1.4000E+00
1.2147E+00	3.7403E+03	1.6928E+03	1.4903E+02	1.0136E+02	4.6305E-05	6.3071E+04	2.3468E+00	1.4000E+00
1.1918E+00	3.6625E+03	1.6364E+03	1.4614E+02	9.7087E+01	4.2246E-05	6.5249E+04	2.2379E+00	1.4000E+00
1.1689E+00	3.5899E+03	1.5626E+03	1.4344E+02	9.3171E+01	3.8851E-05	6.7191E+04	2.1426E+00	1.4000E+00
1.1460E+00	3.5224E+03	1.5314E+03	1.4095E+02	8.9527E+01	3.5960E-05	6.8934E+04	2.0587E+00	1.4000E+00
1.1230E+00	3.4600E+03	1.4826E+03	1.3866E+02	8.6098E+01	3.3462E-05	7.0509E+04	1.9847E+00	1.4000E+00
1.1001E+00	3.4029E+03	1.4362E+03	1.3656E+02	8.2829E+01	3.1275E-05	7.1935E+04	1.9195E+00	1.4000E+00
1.0772E+00	3.3515E+03	1.3924E+03	1.3470E+02	7.9666E+01	2.9334E-05	7.3229E+04	1.8625E+00	1.4000E+00
1.0543E+00	3.3065E+03	1.3509E+03	1.3309E+02	7.6566E+01	2.7593E-05	7.4403E+04	1.8135E+00	1.4000E+00
1.0314E+00	3.2685E+03	1.3117E+03	1.3175E+02	7.3481E+01	2.6006E-05	7.5469E+04	1.7720E+00	1.4000E+00

1.0084E+00	3.2382E+03	1.2743E+03	1.3070E+02	7.0359E+01	2.4536E-05	7.6439E+04	1.7380E+00	1.4000E+00
9.8553E-01	3.2167E+03	1.2382E+03	1.2998E+02	6.7151E+01	2.3152E-05	7.7321E+04	1.7117E+00	1.4000E+00
9.6241E-01	3.2051E+03	1.2026E+03	1.2963E+02	6.3790E+01	2.1820E-05	7.8128E+04	1.6933E+00	1.4000E+00
9.3969E-01	3.2053E+03	1.1666E+03	1.2969E+02	6.0221E+01	2.0515E-05	7.8861E+04	1.6838E+00	1.4000E+00

PLANE 3 ANGLE IS 30.00 DEGREES
THE AXIS IS SHIFTED UP 0.0000 UNITS

STATION 0 Z IS 6.5797986E-01 R IS 9.3969262E-01 BZ IS 3.6397023E-01 BPHI IS 0.
C IS 1.2673139E+00 CZ IS 6.6801566E-01 CPHI IS 3.4268074E-02

R	W	U	V	P	RHO	S	M	GAMMA
1.2673E+00	3.9044E+03	1.8507E+03	2.9909E+02	1.0939E+02	5.6967E-05	5.7617E+04	2.6416E+00	1.4000E+00
1.2439E+00	3.8231E+03	1.7902E+03	2.9327E+02	1.0407E+02	5.0971E-05	6.0318E+04	2.5029E+00	1.4000E+00
1.2205E+00	3.7434E+03	1.7305E+03	2.8754E+02	9.9299E+01	4.6003E-05	6.2782E+04	2.3781E+00	1.4000E+00
1.1971E+00	3.6666E+03	1.6722E+03	2.8201E+02	9.4981E+01	4.1868E-05	6.5011E+04	2.2668E+00	1.4000E+00
1.1737E+00	3.5950E+03	1.6164E+03	2.7685E+02	9.1028E+01	3.8417E-05	6.6998E+04	2.1695E+00	1.4000E+00
1.1503E+00	3.5286E+03	1.5633E+03	2.7211E+02	8.7357E+01	3.5489E-05	6.8779E+04	2.0842E+00	1.4000E+00
1.1269E+00	3.4675E+03	1.5126E+03	2.6775E+02	8.3905E+01	3.2965E-05	7.0385E+04	2.0091E+00	1.4000E+00
1.1035E+00	3.4118E+03	1.4644E+03	2.6379E+02	8.0616E+01	3.0760E-05	7.1837E+04	1.9432E+00	1.4000E+00
1.0801E+00	3.3620E+03	1.4185E+03	2.6028E+02	7.7435E+01	2.8806E-05	7.3154E+04	1.8857E+00	1.4000E+00
1.0567E+00	3.3188E+03	1.3750E+03	2.5725E+02	7.4316E+01	2.7053E-05	7.4347E+04	1.8365E+00	1.4000E+00
1.0333E+00	3.2828E+03	1.3336E+03	2.5476E+02	7.1208E+01	2.5457E-05	7.5428E+04	1.7952E+00	1.4000E+00
1.0099E+00	3.2548E+03	1.2938E+03	2.5286E+02	6.8059E+01	2.3978E-05	7.6412E+04	1.7616E+00	1.4000E+00
9.8650E-01	3.2360E+03	1.2551E+03	2.5160E+02	6.4815E+01	2.2584E-05	7.7306E+04	1.7361E+00	1.4000E+00
9.6309E-01	3.2278E+03	1.2163E+03	2.5107E+02	6.1407E+01	2.1239E-05	7.8121E+04	1.7190E+00	1.4000E+00
9.3969E-01	3.2321E+03	1.1764E+03	2.5137E+02	5.7776E+01	1.9916E-05	7.8861E+04	1.7113E+00	1.4000E+00

PLANE 4 ANGLE IS 45.00 DEGREES
THE AXIS IS SHIFTED UP 0.0000 UNITS

STATION 0 Z IS 6.5797986E-01 R IS 9.3969262E-01 BZ IS 3.6397023E-01 BPHI IS 0.
C IS 1.2784349E+00 CZ IS 6.8144410E-01 CPHI IS 5.0519113E-02

R	W	U	V	P	RHO	S	M	GAMMA
1.2784E+00	3.9053E+03	1.9167E+03	4.2180E+02	1.0643E+02	5.6887E-05	5.6968E+04	2.7006E+00	1.4000E+00
1.2542E+00	3.8260E+03	1.8535E+03	4.1374E+02	1.0099E+02	5.0655E-05	5.9772E+04	2.5567E+00	1.4000E+00
1.2300E+00	3.7481E+03	1.7909E+03	4.0581E+02	9.6118E+01	4.5524E-05	6.2325E+04	2.4277E+00	1.4000E+00
1.2058E+00	3.6731E+03	1.7296E+03	3.9814E+02	9.1729E+01	4.1270E-05	6.4635E+04	2.3126E+00	1.4000E+00
1.1817E+00	3.6031E+03	1.6708E+03	3.9098E+02	8.7725E+01	3.7735E-05	6.6695E+04	2.2121E+00	1.4000E+00
1.1575E+00	3.5385E+03	1.6147E+03	3.8441E+02	8.4016E+01	3.4750E-05	6.8536E+04	2.1244E+00	1.4000E+00
1.1333E+00	3.4794E+03	1.5611E+03	3.7840E+02	8.0535E+01	3.2188E-05	7.0191E+04	2.0476E+00	1.4000E+00
1.1091E+00	3.4259E+03	1.5098E+03	3.7298E+02	7.7222E+01	2.9957E-05	7.1685E+04	1.9805E+00	1.4000E+00

SIMILAR OUTPUT FOR PLANES 5-13 AT STATION 0 REMOVED

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K IS  1   DZ IS 1.7658225E-02   CFL IS 3.6405536E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 6.5797986E-01
K IS  2   DZ IS 1.3061547E-02   CFL IS 3.5592584E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 6.7563808E-01
K IS  3   DZ IS 1.8184873E-02   CFL IS 3.5351204E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 6.9369963E-01
K IS  4   DZ IS 1.8412808E-02   CFL IS 3.4913586E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 7.1188450E-01
K IS  5   DZ IS 1.8703501E-02   CFL IS 3.4370952E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 7.3029731E-01
K IS  6   DZ IS 1.9015425E-02   CFL IS 3.3807141E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 7.4900081E-01
K IS  7   DZ IS 1.9325263E-02   CFL IS 3.3265118E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 7.6801624E-01
K IS  8   DZ IS 1.9626925E-02   CFL IS 3.2753839E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 7.8734150E-01
K IS  9   DZ IS 1.9921950E-02   CFL IS 3.2268785E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 8.0696842E-01
K IS 10   DZ IS 2.0212574E-02   CFL IS 3.1804813E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 8.2689037E-01
K IS 11   DZ IS 2.0499884E-02   CFL IS 3.1359062E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 8.4710295E-01
K IS 12   DZ IS 2.0784086E-02   CFL IS 3.0930259E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 8.6760283E-01
K IS 13   DZ IS 2.1064951E-02   CFL IS 3.0517856E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 8.8338692E-01
K IS 14   DZ IS 2.1342059E-02   CFL IS 3.0121609E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 9.0945187E-01
K IS 15   DZ IS 2.1614904E-02   CFL IS 2.9741383E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 9.3079393E-01
K IS 16   DZ IS 2.1882942E-02   CFL IS 2.9377089E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 9.5240883E-01
K IS 17   DZ IS 2.2145600E-02   CFL IS 2.9028662E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 9.7429177E-01
K IS 18   DZ IS 2.2402290E-02   CFL IS 2.8696046E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 9.9643737E-01
K IS 19   DZ IS 2.2652424E-02   CFL IS 2.8379176E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 1.0188397E+00
K IS 20   DZ IS 2.2895441E-02   CFL IS 2.8077954E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 1.0414921E+00
K IS 21   DZ IS 2.3130818E-02   CFL IS 2.7792236E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 1.0643875E+00
K IS 22   DZ IS 2.3358076E-02   CFL IS 2.7521836E+00   NCFL IS 1   MCFL IS 1   JCFL IS 3   Z IS 1.0875183E+00
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SIMILAR OUTPUT FOR K = 23 - 100, REMOVED

MACH NO IS 1.5000000E+01 ANGLE OF ATTACK IS 7.5000000E+00 ANGLE OF SIDESLIP IS 0.

PLANE 1 ANGLE IS 0.00 DEGREES
THE AXIS IS SHIFTED UP 0.0000 UNITS

STATION 100 Z IS 2.9896021E+00 B IS 1.7883337E+00 BZ IS 3.6397023E-01 BPHI IS 0.
C IS 2.1773809E+00 CZ IS 3.4080704E-01 CPHI IS 0.

R	W	U	V	P	RHO	S	M	GAMMA
2.1774E+00	4.9106E+03	1.1859E+03	0.	5.1436E+01	5.3906E-05	4.0344E+04	4.3709E+00	1.4000E+00
2.1496E+00	4.9008E+03	1.2193E+03	0.	5.2719E+01	5.5113E-05	4.0182E+04	4.3640E+00	1.4000E+00
2.1218E+00	4.8956E+03	1.2567E+03	0.	5.4154E+01	5.6974E-05	3.9681E+04	4.3815E+00	1.4000E+00
2.0940E+00	4.8749E+03	1.2895E+03	0.	5.5497E+01	5.7364E-05	4.0062E+04	4.3329E+00	1.4000E+00
2.0662E+00	4.8215E+03	1.3146E+03	0.	5.6804E+01	5.5032E-05	4.2137E+04	4.1572E+00	1.4000E+00
2.0384E+00	4.7326E+03	1.3330E+03	0.	5.8157E+01	5.0726E-05	4.5647E+04	3.8809E+00	1.4000E+00
2.0106E+00	4.6162E+03	1.3395E+03	0.	5.9119E+01	4.5497E-05	4.9951E+04	3.5637E+00	1.4000E+00
1.9829E+00	4.4754E+03	1.3380E+03	0.	5.9921E+01	4.0407E-05	5.4531E+04	3.2419E+00	1.4000E+00
1.9551E+00	4.3160E+03	1.3278E+03	0.	6.0491E+01	3.5856E-05	5.9039E+04	2.9382E+00	1.4000E+00
1.9273E+00	4.1426E+03	1.3103E+03	0.	6.0868E+01	3.1983E-05	6.3279E+04	2.6618E+00	1.4000E+00
1.8995E+00	3.9598E+03	1.2875E+03	0.	6.1124E+01	2.8789E-05	6.7142E+04	2.4152E+00	1.4000E+00
1.8717E+00	3.7716E+03	1.2604E+03	0.	6.1266E+01	2.6172E-05	7.0604E+04	2.1967E+00	1.4000E+00
1.8439E+00	3.5804E+03	1.2302E+03	0.	6.1334E+01	2.4030E-05	7.3682E+04	2.0027E+00	1.4000E+00
1.8161E+00	3.3883E+03	1.1978E+03	0.	6.1335E+01	2.2263E-05	7.6409E+04	1.8299E+00	1.4000E+00
1.7883E+00	3.1699E+03	1.1538E+03	0.	6.1296E+01	2.0608E-05	7.9151E+04	1.6531E+00	1.4000E+00

PLANE 2 ANGLE IS 15.00 DEGREES
THE AXIS IS SHIFTED UP 0.0000 UNITS

STATION 100 Z IS 2.9896021E+00 B IS 1.7883337E+00 BZ IS 3.6397023E-01 BPHI IS 0.
C IS 2.1830190E+00 CZ IS 3.4009680E-01 CPHI IS 4.4338445E-02

R	W	U	V	P	RHO	S	M	GAMMA
2.1830E+00	4.9185E+03	1.1918E+03	1.5103E+02	5.0460E+01	5.3801E-05	3.9925E+04	4.4185E+00	1.4000E+00
2.1548E+00	4.9090E+03	1.2241E+03	1.4470E+02	5.1633E+01	5.4905E-05	3.9786E+04	4.4111E+00	1.4000E+00
2.1266E+00	4.9033E+03	1.2606E+03	1.3746E+02	5.2995E+01	5.6637E-05	3.9341E+04	4.4250E+00	1.4000E+00
2.0984E+00	4.8802E+03	1.2924E+03	1.3199E+02	5.4271E+01	5.6732E-05	3.9888E+04	4.3638E+00	1.4000E+00
2.0703E+00	4.8246E+03	1.3157E+03	1.2954E+02	5.5454E+01	5.4096E-05	4.2137E+04	4.1757E+00	1.4000E+00
2.0421E+00	4.7341E+03	1.3333E+03	1.2983E+02	5.6748E+01	4.9696E-05	4.5754E+04	3.8913E+00	1.4000E+00
2.0139E+00	4.6173E+03	1.3396E+03	1.3198E+02	5.7672E+01	4.4517E-05	5.0096E+04	3.5712E+00	1.4000E+00
1.9857E+00	4.4769E+03	1.3380E+03	1.3572E+02	5.8444E+01	3.9532E-05	5.4676E+04	3.2492E+00	1.4000E+00
1.9575E+00	4.3183E+03	1.3284E+03	1.4078E+02	5.9016E+01	3.5106E-05	5.9164E+04	2.9464E+00	1.4000E+00
1.9293E+00	4.1464E+03	1.3114E+03	1.4720E+02	5.9391E+01	3.1338E-05	6.3379E+04	2.6714E+00	1.4000E+00
1.9011E+00	3.9653E+03	1.2894E+03	1.5500E+02	5.9650E+01	2.8232E-05	6.7216E+04	2.4261E+00	1.4000E+00

SIMILAR OUTPUT FOR PLANES 3-13 AT STATION K = 100, REMOVED

ALSO ALL PRINTOUT TO STATION 444 REMOVED

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K IS 444   DZ IS 7.3625537E-02   CFL IS 8.7314425E-01   NCFL IS 1   MCFL IS 8   JCFL IS 1   Z IS 1.3225277E+01
K IS 445   DZ IS 7.4318879E-02   CFL IS 8.6499844E-01   NCFL IS 1   MCFL IS 8   JCFL IS 1   Z IS 1.3298902E+01
K IS 446   DZ IS 7.5030051E-02   CFL IS 8.5679955E-01   NCFL IS 1   MCFL IS 8   JCFL IS 1   Z IS 1.3373221E+01
K IS 447   DZ IS 7.5759490E-02   CFL IS 8.4854999E-01   NCFL IS 1   MCFL IS 8   JCFL IS 1   Z IS 1.3448251E+01
K IS 448   DZ IS 7.6212884E-02   CFL IS 8.4350192E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.3524011E+01
K IS 449   DZ IS 7.6621418E-02   CFL IS 8.3900450E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.3600224E+01
K IS 450   DZ IS 7.7042027E-02   CFL IS 8.3442397E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.3676845E+01
K IS 451   DZ IS 7.7474778E-02   CFL IS 8.2976313E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.3753887E+01
K IS 452   DZ IS 7.7919959E-02   CFL IS 8.2502244E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.3831362E+01
K IS 453   DZ IS 7.8377848E-02   CFL IS 8.2020259E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.3909282E+01
K IS 454   DZ IS 7.8848734E-02   CFL IS 8.1530433E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.3987660E+01
K IS 455   DZ IS 7.9332912E-02   CFL IS 8.1032843E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.4066508E+01
K IS 456   DZ IS 7.9830694E-02   CFL IS 8.0527566E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.4145841E+01
K IS 457   DZ IS 8.0342396E-02   CFL IS 8.0014684E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.4225672E+01
K IS 458   DZ IS 8.0868351E-02   CFL IS 7.9494281E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.4306014E+01
K IS 459   DZ IS 8.1408895E-02   CFL IS 7.8966450E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.4386883E+01
K IS 460   DZ IS 8.1964377E-02   CFL IS 7.8431285E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.4468292E+01
K IS 461   DZ IS 8.2535153E-02   CFL IS 7.7888890E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.4550256E+01
K IS 462   DZ IS 8.3121588E-02   CFL IS 7.7339372E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.4632791E+01
K IS 463   DZ IS 8.3724056E-02   CFL IS 7.6782848E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.4715913E+01
K IS 464   DZ IS 8.4342941E-02   CFL IS 7.6219437E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.4799637E+01
K IS 465   DZ IS 8.4978637E-02   CFL IS 7.5649265E-01   NCFL IS 1   MCFL IS 9   JCFL IS 1   Z IS 1.4883980E+01
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K IS  466     DZ IS  8.5631551E-02     CFL IS  7.5072463E-01     NCFL IS  1     MCFL IS  9     JCFL IS  1     Z IS  1.4968958E+01

JUMP IS CALLED FOR PLANE   1      PHI IS   0.00      K IS 466      Z IS     1.505459E+01
                                  THE INPUT VARIABLES ARE AS FOLLOWS
P.D.U.V.W.S.ASQ              7.02703E+01   4.58753E-05   1.58506E+03   0.            4.35491E+03   5.40617E+04   2.14448E+06
R.RZ.RPHI.DRP.DRZ.HOTZ       6.16454E+00   8.74887E-02   0.            0.            2.76482E-01   3.22000E+07
                        SUPERSONIC EXPANSION CORNER WHERE
THETA.AMACH.QT.QSM           1.50000E+01   3.16470E+00   0.            4.63439E+03
                                  THE OUTPUT VARIABLES ARE AS FOLLOWS
P.D.U.V.W.S.ASQ              1.76113E+01   1.70640E-05   4.35565E+02   0.            4.97853E+03   5.40617E+04   1.44491E+06

JUMP IS CALLED FOR PLANE   2      PHI IS  15.00      K IS 466      Z IS     1.505459E+01
                                  THE INPUT VARIABLES ARE AS FOLLOWS
P.D.U.V.W.S.ASQ              6.89445E+01   4.49370E-05   1.58324E+03   1.78166E+02   4.34993E+03   5.43138E+04   2.14795E+06
R.RZ.RPHI.DRP.DRZ.HOTZ       6.16454E+00   8.74887E-02   0.            0.            2.76482E-01   3.22000E+07
                        SUPERSONIC EXPANSION CORNER WHERE
THETA.AMACH.QT.QSM           1.50000E+01   3.15853E+00  -1.78166E+02   4.62910E+03
                                  THE OUTPUT VARIABLES ARE AS FOLLOWS
P.D.U.V.W.S.ASQ              1.73238E+01   1.67459E-05   4.35139E+02   1.78166E+02   4.97367E+03   5.43138E+04   1.44831E+06

JUMP IS CALLED FOR PLANE   3      PHI IS  30.00      K IS 466      Z IS     1.505459E+01
                                  THE INPUT VARIABLES ARE AS FOLLOWS
P.D.U.V.W.S.ASQ              6.51614E+01   4.21699E-05   1.57690E+03   3.55358E+02   4.33251E+03   5.51438E+04   2.16330E+06
R.RZ.RPHI.DRP.DRZ.HOTZ       6.16454E+00   8.74887E-02   0.            0.            2.76482E-01   3.22000E+07
                        SUPERSONIC EXPANSION CORNER WHERE
THETA.AMACH.QT.QSM           1.50000E+01   3.13470E+00  -3.55358E+02   4.61056E+03
                                  THE OUTPUT VARIABLES ARE AS FOLLOWS
P.D.U.V.W.S.ASQ              1.65372E+01   1.58272E-05   4.33679E+02   3.55358E+02   4.95698E+03   5.51438E+04   1.46280E+06

JUMP IS CALLED FOR PLANE   4      PHI IS  45.00      K IS 466      Z IS     1.505459E+01
                                  THE INPUT VARIABLES ARE AS FOLLOWS
P.D.U.V.W.S.ASQ              5.94165E+01   3.77762E-05   1.56389E+03   5.31206E+02   4.29675E+03   5.67185E+04   2.20200E+06
R.RZ.RPHI.DRP.DRZ.HOTZ       6.16454E+00   8.74887E-02   0.            0.            2.76482E-01   3.22000E+07
                        SUPERSONIC EXPANSION CORNER WHERE
THETA.AMACH.QT.QSM           1.50000E+01   3.08139E+00  -5.31206E+02   4.57251E+03
                                  THE OUTPUT VARIABLES ARE AS FOLLOWS
P.D.U.V.W.S.ASQ              1.54177E+01   1.44051E-05   4.30745E+02   5.31206E+02   4.92344E+03   5.67185E+04   1.49841E+06

JUMP IS CALLED FOR PLANE   5      PHI IS  60.00      K IS 466      Z IS     1.505459E+01
                                  THE INPUT VARIABLES ARE AS FOLLOWS
P.D.U.V.W.S.ASQ              5.24200E+01   3.21564E-05   1.54076E+03   7.03586E+02   4.23319E+03   5.92744E+04   2.28222E+06
R.RZ.RPHI.DRP.DRZ.HOTZ       6.16454E+00   8.74887E-02   0.            0.            2.76482E-01   3.22000E+07
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SIMILAR PRINTOUT FOR PLANES 6-13 AT STATION 466, REMOVED

ALSO ALL PRINTOUT TO STATION 487 REMOVED

MACH NO IS 1.5000000E+01   ANGLE OF ATTACK IS 7.5000000E+00   ANGLE OF SIDESLIP IS 0.

PLANE 1 ANGLE IS 0.00 DEGREES
THE AXIS IS SHIFTED UP 0.0000 UNITS

STATION 487   Z IS 2.0105817E+01   B IS 6.6064622E+00   BZ IS 8.7488664E-02   BPHI IS 0.
C IS 9.1298390E+00   CZ IS 3.4571545E-01   CPHI IS 0.

R	W	U	V	P	RHO	S	M	GAMMA
9.1298E+00	4.8961E+03	1.2008E+03	0.	5.2355E+01	5.4002E-05	4.0732E+04	4.3271E+00	1.4000E+00
8.9496E+00	4.8804E+03	1.1144E+03	0.	4.5749E+01	4.4853E-05	4.3920E+04	4.1892E+00	1.4000E+00
8.7694E+00	4.8959E+03	1.0306E+03	0.	3.9751E+01	3.8820E-05	4.5495E+04	4.1786E+00	1.4000E+00
8.5391E+00	4.9331E+03	9.4877E+02	0.	3.4510E+01	3.4684E-05	4.5910E+04	4.2563E+00	1.4000E+00
8.4089E+00	4.9767E+03	8.6347E+02	0.	2.9793E+01	3.1187E-05	4.5957E+04	4.3676E+00	1.4000E+00
8.2286E+00	5.0196E+03	7.7114E+02	0.	2.5524E+01	2.7879E-05	4.6017E+04	4.4857E+00	1.4000E+00
8.0484E+00	5.0629E+03	6.7244E+02	0.	2.1726E+01	2.4872E-05	4.5982E+04	4.6185E+00	1.4000E+00
7.8682E+00	5.1040E+03	5.6800E+02	0.	1.8379E+01	2.2081E-05	4.5966E+04	4.7573E+00	1.4000E+00
7.6879E+00	5.1407E+03	4.6330E+02	0.	1.5549E+01	1.9583E-05	4.5988E+04	4.8956E+00	1.4000E+00
7.5077E+00	5.1727E+03	3.7153E+02	0.	1.3384E+01	1.7661E-05	4.5852E+04	5.0348E+00	1.4000E+00
7.3274E+00	5.1831E+03	3.2971E+02	0.	1.2362E+01	1.6555E-05	4.6134E+04	5.0796E+00	1.4000E+00
7.1472E+00	5.1745E+03	3.6464E+02	0.	1.2716E+01	1.6823E-05	4.6282E+04	5.0426E+00	1.4000E+00
6.9669E+00	5.1978E+03	4.1442E+02	0.	1.3299E+01	1.8576E-05	4.3887E+04	5.2082E+00	1.4000E+00
6.7867E+00	5.1545E+03	4.2955E+02	0.	1.3359E+01	1.7168E-05	4.6816E+04	4.9556E+00	1.4000E+00
6.6065E+00	5.0966E+03	4.4589E+02	0.	1.3304E+01	1.5454E-05	5.0465E+04	4.6602E+00	1.4000E+00

PLANE 2 ANGLE IS 15.00 DEGREES
THE AXIS IS SHIFTED UP 0.0000 UNITS

STATION 487   Z IS 2.0105817E+01   B IS 6.6064622E+00   BZ IS 8.7488664E-02   BPHI IS 0.
C IS 9.1342728E+00   CZ IS 3.4835129E-01   CPHI IS 2.9315860E-02

R	W	U	V	P	RHO	S	M	GAMMA
9.1343E+00	4.8947E+03	1.2151E+03	1.8343E+02	5.1887E+01	5.3954E-05	4.0535E+04	4.3492E+00	1.4000E+00
8.9537E+00	4.8809E+03	1.1298E+03	1.7898E+02	4.5316E+01	4.4875E-05	4.3660E+04	4.2162E+00	1.4000E+00
8.7732E+00	4.8981E+03	1.0457E+03	1.7251E+02	3.9329E+01	3.8857E-05	4.5188E+04	4.2100E+00	1.4000E+00
8.5926E+00	4.9361E+03	9.6343E+02	1.6564E+02	3.4095E+01	3.4696E-05	4.5590E+04	4.2901E+00	1.4000E+00
8.4120E+00	4.9800E+03	8.7754E+02	1.5907E+02	2.9396E+01	3.1157E-05	4.5649E+04	4.4020E+00	1.4000E+00
8.2315E+00	5.0231E+03	7.8458E+02	1.5336E+02	2.5153E+01	2.7816E-05	4.5723E+04	4.5205E+00	1.4000E+00
8.0509E+00	5.0667E+03	6.8517E+02	1.4784E+02	2.1379E+01	2.4789E-05	4.5691E+04	4.6549E+00	1.4000E+00
7.8704E+00	5.1079E+03	5.7983E+02	1.4297E+02	1.8053E+01	2.1967E-05	4.5693E+04	4.7945E+00	1.4000E+00
7.6898E+00	5.1450E+03	4.7397E+02	1.3863E+02	1.5238E+01	1.9447E-05	4.5719E+04	4.9350E+00	1.4000E+00
7.5093E+00	5.1774E+03	3.7992E+02	1.3430E+02	1.3067E+01	1.7481E-05	4.5606E+04	5.0764E+00	1.4000E+00
7.3287E+00	5.1883E+03	3.3419E+02	1.3164E+02	1.2002E+01	1.6306E-05	4.5924E+04	5.1232E+00	1.4000E+00

SIMILAR OUTPUT FOR PLANES 3-13 AT STATION 487, REMOVED

MACH NO = 15.000   ANGLE OF ATTACK = 7.500   ANGLE OF SIDESLIP = 0.000   Z0 = 0.000

S U R F A C E   P R E S S U R E   R A T I O

Z+Z0	0.0	15.0	30.0	45.0	60.0	75.0	90.0	105.0	120.0	135.0	150.0	165.0	180.0
.658	61.074	60.221	57.776	54.061	49.526	44.659	39.897	35.576	31.916	29.034	26.976	25.748	25.340
.676	60.148	59.288	56.830	53.103	48.567	43.715	38.981	34.699	31.082	28.241	26.215	25.007	24.606
.694	60.685	59.810	57.311	53.522	48.916	43.993	39.198	34.865	31.211	28.343	26.301	25.085	24.680
.712	60.830	59.956	57.458	53.666	49.049	44.107	39.289	34.934	31.261	28.379	26.329	25.107	24.700
.730	60.727	59.858	57.375	53.605	49.012	44.090	39.283	34.932	31.259	28.375	26.322	25.099	24.691
.749	60.521	59.653	57.177	53.423	48.857	43.967	39.192	34.866	31.208	28.334	26.286	25.065	24.658
.768	60.291	59.421	56.942	53.190	48.637	43.775	39.035	34.742	31.112	28.257	26.221	25.006	24.601
.787	60.063	59.190	56.704	52.945	48.394	43.547	38.833	34.575	30.976	28.146	26.127	24.922	24.519
.807	59.837	58.962	56.469	52.703	48.147	43.305	38.609	34.378	30.809	28.006	26.006	24.813	24.413
.827	59.610	58.733	56.237	52.465	47.905	43.063	38.377	34.166	30.623	27.844	25.864	24.683	24.287
.847	59.379	58.501	56.003	52.229	47.667	42.825	38.145	33.948	30.425	27.668	25.706	24.537	24.145
.868	59.142	58.263	55.765	51.992	47.431	42.591	37.916	33.729	30.222	27.483	25.538	24.379	23.991
.888	58.897	58.018	55.521	51.751	47.194	42.360	37.692	33.514	30.020	27.296	25.364	24.214	23.829
.909	58.646	57.767	55.271	51.505	46.956	42.131	37.471	33.303	29.819	27.108	25.187	24.046	23.664
.931	58.389	57.510	55.016	51.255	46.714	41.900	37.253	33.095	29.622	26.922	25.012	23.878	23.498
.952	58.127	57.248	54.756	51.000	46.469	41.668	37.035	32.890	29.429	26.739	24.838	23.710	23.332
.974	57.863	56.984	54.493	50.741	46.220	41.434	36.816	32.686	29.238	26.559	24.667	23.545	23.169
.996	57.598	56.719	54.229	50.481	45.968	41.197	36.597	32.484	29.050	26.382	24.499	23.383	23.008
1.019	57.333	56.454	53.964	50.219	45.715	40.957	36.376	32.281	28.863	26.208	24.333	23.223	22.850
1.041	57.070	56.190	53.700	49.958	45.460	40.716	36.153	32.078	28.677	26.035	24.170	23.066	22.695
1.064	56.811	55.930	53.439	49.698	45.206	40.474	35.929	31.874	28.491	25.864	24.009	22.911	22.542
1.088	56.556	55.674	53.181	49.440	44.953	40.232	35.703	31.669	28.305	25.693	23.850	22.758	22.391
1.111	56.306	55.423	52.927	49.185	44.703	39.990	35.477	31.463	28.119	25.523	23.691	22.606	22.241
1.134	56.062	55.177	52.678	48.935	44.454	39.750	35.252	31.256	27.932	25.353	23.533	22.456	22.093
1.158	55.825	54.937	52.435	48.689	44.210	39.513	35.027	31.050	27.745	25.184	23.376	22.306	21.946
1.182	55.594	54.704	52.197	48.447	43.969	39.278	34.804	30.843	27.558	25.014	23.219	22.157	21.800
1.206	55.372	54.479	51.966	48.212	43.732	39.046	34.583	30.638	27.370	24.844	23.063	22.009	21.654
1.231	55.158	54.261	51.742	47.982	43.501	38.818	34.365	30.433	27.184	24.674	22.906	21.861	21.509
1.255	54.952	54.052	51.525	47.758	43.274	38.594	34.149	30.231	26.997	24.504	22.750	21.713	21.363
1.280	54.755	53.851	51.316	47.540	43.052	38.374	33.937	30.031	26.812	24.335	22.594	21.566	21.219
1.305	54.568	53.659	51.114	47.330	42.836	38.159	33.728	29.833	26.629	24.166	22.439	21.418	21.075
1.330	54.390	53.475	50.921	47.126	42.625	37.948	33.522	29.638	26.447	23.999	22.284	21.272	20.931
1.355	54.221	53.301	50.736	46.929	42.421	37.741	33.321	29.446	26.268	23.833	22.129	21.126	20.788
1.380	54.060	53.135	50.559	46.740	42.222	37.540	33.123	29.257	26.090	23.668	21.976	20.981	20.645
1.405	53.909	52.979	50.391	46.559	42.030	37.343	32.929	29.072	25.916	23.506	21.825	20.836	20.504
1.431	53.768	52.831	50.231	46.384	41.844	37.152	32.740	28.889	25.744	23.345	21.674	20.693	20.363
1.456	53.635	52.693	50.080	46.218	41.664	36.965	32.554	28.711	25.575	23.187	21.526	20.552	20.224
1.482	53.511	52.564	49.938	46.059	41.491	36.785	32.373	28.535	25.409	23.031	21.379	20.412	20.086

SIMILAR PRINTOUT FOR $1.482 < Z+Z_0 < 14.226$, REMOVED

MACH NO = 15.000   ANGLE OF ATTACK = 7.500   ANGLE OF SIDESLIP = 0.000   Z0 = 0.000

S U R F A C E   P R E S S U R E   R A T I O

Z+Z0	0.0	15.0	30.0	45.0	60.0	75.0	90.0	105.0	120.0	135.0	150.0	165.0	180.0
14.226	70.285	68.959	65.178	59.430	52.419	44.944	37.698	31.265	25.679	20.998	17.706	15.961	15.433
14.306	70.285	68.958	65.177	59.429	52.420	44.945	37.701	31.267	25.689	21.016	17.734	15.996	15.472
14.387	70.284	68.957	65.176	59.428	52.421	44.945	37.703	31.269	25.698	21.034	17.762	16.032	15.512
14.468	70.283	68.957	65.175	59.428	52.422	44.946	37.706	31.271	25.707	21.052	17.789	16.068	15.551
14.550	70.282	68.956	65.174	59.427	52.423	44.946	37.708	31.272	25.716	21.069	17.816	16.103	15.591
14.633	70.281	68.955	65.172	59.426	52.424	44.947	37.711	31.274	25.725	21.086	17.843	16.139	15.631
14.716	70.281	68.954	65.171	59.425	52.424	44.947	37.713	31.275	25.734	21.103	17.870	16.175	15.672
14.800	70.280	68.954	65.170	59.425	52.425	44.947	37.715	31.276	25.742	21.119	17.896	16.210	15.712
14.884	70.279	68.953	65.169	59.424	52.425	44.947	37.717	31.278	25.751	21.135	17.922	16.246	15.753
14.969	70.278	68.952	65.168	59.423	52.425	44.947	37.719	31.279	25.759	21.151	17.947	16.282	15.793
15.055	17.611	17.324	16.537	15.418	14.172	12.932	11.744	10.572	9.193	7.590	6.283	5.550	5.325
15.142	18.125	17.809	16.935	15.667	14.219	12.742	11.318	9.971	8.633	7.307	6.248	5.636	5.445
15.246	18.471	18.120	17.135	15.690	14.015	12.299	10.683	9.259	8.039	6.964	6.148	5.685	5.542
15.367	17.515	17.159	16.162	14.706	13.032	11.347	9.804	8.497	7.423	6.514	5.853	5.495	5.388
15.496	16.491	16.140	15.162	13.747	12.145	10.562	9.132	7.921	6.943	6.154	5.599	5.307	5.222
15.639	15.577	15.232	14.276	12.907	11.381	9.895	8.554	7.414	6.536	5.864	5.401	5.164	5.096
15.797	14.775	14.432	13.485	12.143	10.664	9.242	7.970	6.922	6.171	5.619	5.249	5.067	5.017
15.974	14.054	13.705	12.747	11.397	9.928	8.542	7.352	6.435	5.821	5.385	5.113	5.000	4.973
16.171	13.434	13.073	12.079	10.687	9.193	7.832	6.740	5.965	5.466	5.135	4.970	4.940	4.943
16.383	12.991	12.610	11.563	10.101	8.559	7.210	6.202	5.531	5.114	4.872	4.808	4.868	4.908
16.605	12.752	12.348	11.238	9.692	8.079	6.717	5.752	5.137	4.773	4.601	4.627	4.775	4.855
16.840	12.689	12.264	11.092	9.453	7.750	6.342	5.378	4.781	4.452	4.334	4.433	4.662	4.781
17.087	12.750	12.308	11.082	9.355	7.549	6.065	5.065	4.463	4.153	4.076	4.235	4.535	4.690
17.347	12.877	12.425	11.161	9.358	7.446	5.863	4.804	4.181	3.880	3.832	4.039	4.400	4.588
17.621	13.023	12.567	11.283	9.426	7.415	5.722	4.586	3.932	3.632	3.604	3.847	4.260	4.480
17.909	13.153	12.699	11.412	9.525	7.433	5.627	4.405	3.712	3.406	3.390	3.659	4.118	4.367
18.214	13.252	12.803	11.526	9.631	7.480	5.569	4.255	3.517	3.200	3.188	3.476	3.973	4.249
18.539	13.315	12.873	11.613	9.729	7.544	5.540	4.132	3.344	3.010	2.997	3.296	3.824	4.125
18.887	13.346	12.911	11.671	9.809	7.613	5.534	4.033	3.191	2.835	2.815	3.119	3.672	3.994
19.262	13.351	12.923	11.702	9.867	7.680	5.545	3.955	3.055	2.673	2.641	2.944	3.515	3.858
19.668	13.335	12.913	11.710	9.905	7.739	5.570	3.898	2.936	2.523	2.475	2.773	3.355	3.715
20.106	13.304	12.887	11.699	9.922	7.787	5.604	3.860	2.834	2.386	2.318	2.606	3.193	3.569

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                          A E R O D Y N A M I C   D A T A

                      F R E E   S T R E A M   C O N D I T I O N S
MACH NO. =   1.500000E+01        ANGLE OF ATTACK =   7.500000E+00   ANGLE OF SIDESLIP =   0.
    VINF =   5.612486E+03  TOTAL ANGLE OF ATTACK =   7.500000E+00     AERO ROLL ANGLE =   0.
    PINF =   1.000000E+00                   DINF =   1.000000E-05                SINF =   0.
PERFECT GAS    (GAMMA =   1.400000E+00)

                       R E F E R E N C E   Q U A N T I T I E S
REFERENCE LENGTH IS   2.000000E+01      REFERENCE AREA IS   1.367319E+02      Z0 IS   0.

               A E R O D Y N A M I C   C O E F F I C I E N T S   A T   T A R G E T E D   Z   L O C A T I O N S
                  FORCE COEFFICIENTS                    MOMENT COEFFICIENTS ABOUT Z =   0.                 CENTERS OF PRESSURE
   Z+Z0         CN             CA             CY             CMN             CMM             CML              XCPP           XCPY
  20.000   2.28039E-01   2.29741E-01   -0.            -0.            -1.34812E-01   -0.            5.91181E-01                  I
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A E R O D Y N A M I C   D A T A

Z DERIVATIVES OF FORCE AND MOMENT COEFFICIENTS

Z+Z0	CNZ	CAZ	CYZ	CMNZ	CMMZ	CMLZ
.658	2.43762E-03	4.04642E-03	-0.	-0.	-1.21881E-04	-0.
.676	2.43962E-03	3.98625E-03	-0.	-0.	-1.24420E-04	-0.
.694	2.48818E-03	4.04035E-03	-0.	-0.	-1.29441E-04	-0.
.712	2.51515E-03	4.07743E-03	-0.	-0.	-1.33435E-04	-0.
.730	2.52659E-03	4.10266E-03	-0.	-0.	-1.36675E-04	-0.
.749	2.53112E-03	4.12037E-03	-0.	-0.	-1.39601E-04	-0.
.768	2.53507E-03	4.13379E-03	-0.	-0.	-1.42549E-04	-0.
.787	2.54119E-03	4.14481E-03	-0.	-0.	-1.45674E-04	-0.
.807	2.54998E-03	4.15446E-03	-0.	-0.	-1.49011E-04	-0.
.827	2.56095E-03	4.16328E-03	-0.	-0.	-1.52542E-04	-0.
.847	2.57338E-03	4.17161E-03	-0.	-0.	-1.56227E-04	-0.
.868	2.58654E-03	4.17965E-03	-0.	-0.	-1.60028E-04	-0.
.888	2.59989E-03	4.18750E-03	-0.	-0.	-1.63914E-04	-0.
.909	2.61304E-03	4.19526E-03	-0.	-0.	-1.67860E-04	-0.
.931	2.62581E-03	4.20296E-03	-0.	-0.	-1.71853E-04	-0.
.952	2.63813E-03	4.21062E-03	-0.	-0.	-1.75888E-04	-0.
.974	2.65003E-03	4.21829E-03	-0.	-0.	-1.79965E-04	-0.
.996	2.66162E-03	4.22596E-03	-0.	-0.	-1.84090E-04	-0.
1.019	2.67304E-03	4.23368E-03	-0.	-0.	-1.88271E-04	-0.
1.041	2.68443E-03	4.24146E-03	-0.	-0.	-1.92516E-04	-0.
1.064	2.69595E-03	4.24933E-03	-0.	-0.	-1.96837E-04	-0.
1.088	2.70771E-03	4.25730E-03	-0.	-0.	-2.01243E-04	-0.
1.111	2.71984E-03	4.26540E-03	-0.	-0.	-2.05742E-04	-0.
1.134	2.73243E-03	4.27366E-03	-0.	-0.	-2.10342E-04	-0.
1.158	2.74556E-03	4.28209E-03	-0.	-0.	-2.15050E-04	-0.
1.182	2.75930E-03	4.29072E-03	-0.	-0.	-2.19875E-04	-0.
1.206	2.77371E-03	4.29958E-03	-0.	-0.	-2.24820E-04	-0.
1.231	2.78883E-03	4.30870E-03	-0.	-0.	-2.29892E-04	-0.
1.255	2.80470E-03	4.31809E-03	-0.	-0.	-2.35095E-04	-0.
1.280	2.82133E-03	4.32778E-03	-0.	-0.	-2.40434E-04	-0.
1.305	2.83875E-03	4.33780E-03	-0.	-0.	-2.45911E-04	-0.
1.330	2.85696E-03	4.34815E-03	-0.	-0.	-2.51529E-04	-0.
1.355	2.87596E-03	4.35886E-03	-0.	-0.	-2.57290E-04	-0.
1.380	2.89573E-03	4.36995E-03	-0.	-0.	-2.63194E-04	-0.
1.405	2.91628E-03	4.38142E-03	-0.	-0.	-2.69244E-04	-0.
1.431	2.93758E-03	4.39330E-03	-0.	-0.	-2.75440E-04	-0.
1.456	2.95965E-03	4.40559E-03	-0.	-0.	-2.81785E-04	-0.
1.482	2.98248E-03	4.41830E-03	-0.	-0.	-2.88280E-04	-0.

SIMILAR PRINTOUT FOR $1.482 < Z+Z_0 < 14.226$, REMOVED

A E R O D Y N A M I C   D A T A

7 DERIVATIVES OF FORCE AND MOMENT COEFFICIENTS

Z+Z0	CNZ	CAZ	CYZ	CMNZ	CMMZ	CMLZ
14.226	2.34114E-02	2.45049E-02	-0.	-0.	-1.91564E-02	-0.
14.306	2.35138E-02	2.46327E-02	-0.	-0.	-1.93472E-02	-0.
14.387	2.36169E-02	2.47613E-02	-0.	-0.	-1.95402E-02	-0.
14.468	2.37207E-02	2.48908E-02	-0.	-0.	-1.97354E-02	-0.
14.550	2.38252E-02	2.50211E-02	-0.	-0.	-1.99329E-02	-0.
14.633	2.39304E-02	2.51522E-02	-0.	-0.	-2.01328E-02	-0.
14.716	2.40364E-02	2.52843E-02	-0.	-0.	-2.03351E-02	-0.
14.800	2.41431E-02	2.54173E-02	-0.	-0.	-2.05399E-02	-0.
14.884	2.42507E-02	2.55512E-02	-0.	-0.	-2.07472E-02	-0.
14.969	2.43591E-02	2.56861E-02	-0.	-0.	-2.09571E-02	-0.
15.055	5.25093E-03	1.66243E-03	-0.	-0.	-4.09412E-03	-0.
15.142	5.51882E-03	1.65780E-03	-0.	-0.	-4.32719E-03	-0.
15.245	5.70123E-03	1.63095E-03	-0.	-0.	-4.50026E-03	-0.
15.367	5.35852E-03	1.52047E-03	-0.	-0.	-4.26237E-03	-0.
15.496	4.98220E-03	1.42064E-03	-0.	-0.	-3.99535E-03	-0.
15.639	4.63893E-03	1.33484E-03	-0.	-0.	-3.75347E-03	-0.
15.797	4.31923E-03	1.25696E-03	-0.	-0.	-3.52929E-03	-0.
15.974	4.01017E-03	1.18143E-03	-0.	-0.	-3.31247E-03	-0.
16.171	3.73478E-03	1.10917E-03	-0.	-0.	-3.12212E-03	-0.
16.383	3.54638E-03	1.04724E-03	-0.	-0.	-3.00237E-03	-0.
16.605	3.46949E-03	9.98979E-04	-0.	-0.	-2.97618E-03	-0.
16.840	3.49401E-03	9.63672E-04	-0.	-0.	-3.03850E-03	-0.
17.087	3.59475E-03	9.39051E-04	-0.	-0.	-3.17086E-03	-0.
17.347	3.74357E-03	9.22336E-04	-0.	-0.	-3.35123E-03	-0.
17.621	3.91569E-03	9.10877E-04	-0.	-0.	-3.55937E-03	-0.
17.909	4.09285E-03	9.02485E-04	-0.	-0.	-3.77988E-03	-0.
18.214	4.26431E-03	8.95595E-04	-0.	-0.	-4.00374E-03	-0.
18.539	4.42541E-03	8.89268E-04	-0.	-0.	-4.22739E-03	-0.
18.887	4.57509E-03	8.83056E-04	-0.	-0.	-4.45060E-03	-0.
19.262	4.71392E-03	8.76832E-04	-0.	-0.	-4.67470E-03	-0.
19.668	4.84330E-03	8.70643E-04	-0.	-0.	-4.90194E-03	-0.
20.106	4.96416E-03	8.64622E-04	-0.	-0.	-5.13389E-03	-0.

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        PROGRAM D3CSS       VERSION  10       DATE    03/21/77        TIME   18.56.47
3-D SUPERSONIC FLOW  -  FLOW IS NONSYMMETRICAL
MAXIMUM NO. OF STEPS = 2000        LAST Z VALUE =   3.300000E+01       CFL FACTOR =  .900
ERROR LIMIT   1.0000E-03  MAXIMUM NUMBER OF ITERATIONS   20
PRINT CONTROLS ARE      ZPRINT  1000000.00  1000000.00  1000000.00  1000000.00  1000000.00
                        KOUT           100          20          20          20          20
                        DZPRINT 1000000.00
MACH NO. =    15.00      ANGLE OF ATTACK =    7.50      YAW ANGLE =    0.00    VINF =    5612.49
FREE STREAM PROPERTIES , PINF =    1.0000E+00 DINF =    1.0000E-05 HINF =    3.5000E+05 HO =    1.6100E+07 SINF =    0.
PERFECT GAS    (GAMMA =  1.40     GAS CONSTANT =    1.020191E+04)
FLOW IS PERIODIC WITH PERIOD = 180.00
CALC. BEGINS AT Z =    .2010582E+02
RADIAL INTERVALS NA =  12       TANGENTIAL INTERVALS MA =  24
REZONE THE MESH IN THIS RUN

        PROGRAM BODY        VERSION   3
BODY IS SPHERICALLY BLUNTED AND SPHERE ENDS AT Z=    .6579799E+00    WITH B=    .9396926E+00
 AFT BODY IS A MULTIPLE CONIC WITH
     ANGLE    20.0000 UP TO     15.0000
     ANGLE     5.0000 UP TO **********
THERE IS A WIND CUT OF
     ANGLE     0.0000 BEGINNING AT    35.0000
     ANGLE     0.0000 BEGINNING AT    50.0000
         WITH A FLAP OF HALF-WIDTH     4.7415 LENGTH ALONG Z-AXIS      12.0000   AT     5.0000 DEGREES

        PROGRAM TRANG       VERSION   1
EQUAL SPACING IN TANGENTIAL DIRECTION

        PROGRAM TRANF       VERSION   1
EQUAL SPACING IN RADIAL DIRECTION



             ADDITIONAL FEATURES

BACKWARD DIFFERENCE FOR PREDICTOR STEP AND FORWARD DIFFERENCE FOR CORRECTOR STEP IN X DIRECTION

WALL ENTROPY EXTRAPOLATION FOR 25 PLANES UNTIL A COMPRESSION JUMP AND THEN NO EXTRAPOLATION

MOD 3 FOR WALL POINTS UNTIL A JUMP OCCURS AND THEN MOD 0 IS USED

SECOND ORDER ACCURACY IS USED AT WALL POINTS FOR Z LESS THAN    1.000000E+06 OR UNTIL JUMP IS CALLED

IF PRESSURE IS NEGATIVE THEN THE CONSERVATION VECTORS ARE SMOOTHED BY 1- 2-1

USING JUMP WHICH COMPUTES JUMPS CORRESPONDING TO DISCONTS. IN RZ AND/OR RPHI EXCEPT FOR THE PHI INTERVAL (    0.00,    0.00)

THE CFL FACTOR IS REDUCED TO  .300 WHEN Z IS IN THE INTERVAL (     0.00,     0.00)

USE CFL FACTOR =  .300 FOR  0 STEPS AFTER AN EXPANSION JUMP OCCURS

THE TERMS FOR X DERIVATIVES AT THE WALL ARE MODIFIED FOR
      0 STEPS AFTER AN EXPANSION JUMP AND  4 STEPS AFTER A COMPRESSION JUMP
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MACH NO IS 1.5000000E+01   ANGLE OF ATTACK IS 7.5000000E+00   ANGLE OF SIDESLIP IS 0.

PLANE 1   ANGLE IS 0.00 DEGREES
THE AXIS IS SHIFTED UP 0.0000 UNITS

STATION 487   Z IS 2.0105817E+01   R IS 6.6064622E+00   BZ IS 8.7488664E-02   BPHI IS 0.
C IS 9.1298390E+00   CZ IS 3.4571545E-01   CPHI IS 0.

R	W	U	V	P	RHO	S	M	GAMMA
9.1298E+00	4.8961E+03	1.2008E+03	0.	5.2355E+01	5.4002E-05	4.0732E+04	4.3271E+00	1.4000E+00
8.9196E+00	4.8831E+03	1.1005E+03	0.	4.4749E+01	4.3848E-05	4.4166E+04	4.1877E+00	1.4000E+00
8.7093E+00	4.9080E+03	1.0033E+03	0.	3.8004E+01	3.7441E-05	4.5639E+04	4.2023E+00	1.4000E+00
8.4990E+00	4.9544E+03	9.0612E+02	0.	3.2151E+01	3.2935E-05	4.5952E+04	4.3082E+00	1.4000E+00
8.2887E+00	5.0048E+03	8.0192E+02	0.	2.6947E+01	2.8981E-05	4.6015E+04	4.4425E+00	1.4000E+00
8.0784E+00	5.0554E+03	6.8889E+02	0.	2.2359E+01	2.5373E-05	4.6003E+04	4.5935E+00	1.4000E+00
7.8682E+00	5.1040E+03	5.6800E+02	0.	1.8379E+01	2.2081E-05	4.5966E+04	4.7573E+00	1.4000E+00
7.6579E+00	5.1459E+03	4.4800E+02	0.	1.5188E+01	1.9263E-05	4.5978E+04	4.9163E+00	1.4000E+00
7.4476E+00	5.1761E+03	3.5759E+02	0.	1.3043E+01	1.7292E-05	4.5948E+04	5.0490E+00	1.4000E+00
7.2373E+00	5.1788E+03	3.4718E+02	0.	1.2539E+01	1.6689E-05	4.6210E+04	5.0609E+00	1.4000E+00
7.0270E+00	5.1907E+03	3.9783E+02	0.	1.3105E+01	1.7992E-05	4.4652E+04	5.1552E+00	1.4000E+00
6.8167E+00	5.1622E+03	4.2703E+02	0.	1.3349E+01	1.7402E-05	4.6312E+04	4.9984E+00	1.4000E+00
6.6065E+00	5.0966E+03	4.4589E+02	0.	1.3304E+01	1.5454E-05	5.0465E+04	4.6602E+00	1.4000E+00

PLANE 2   ANGLE IS 7.50 DEGREES
THE AXIS IS SHIFTED UP 0.0000 UNITS

STATION 487   Z IS 2.0105817E+01   R IS 6.6064622E+00   BZ IS 8.7488664E-02   BPHI IS 0.
C IS 9.1320559E+00   CZ IS 3.4703337E-01   CPHI IS 1.4657930E-02

R	W	U	V	P	RHO	S	M	GAMMA
9.1321E+00	4.8962E+03	1.2079E+03	9.1717E+01	5.2121E+01	5.3978E-05	4.0634E+04	4.3381E+00	1.4000E+00
8.9216E+00	4.8843E+03	1.1091E+03	8.8951E+01	4.4534E+01	4.3860E-05	4.4033E+04	4.2014E+00	1.4000E+00
8.7111E+00	4.9100E+03	1.0108E+03	8.5109E+01	3.7794E+01	3.7456E-05	4.5484E+04	4.2183E+00	1.4000E+00
8.5007E+00	4.9566E+03	9.1330E+02	8.1177E+01	3.1948E+01	3.2931E-05	4.5795E+04	4.3252E+00	1.4000E+00
8.2902E+00	5.0071E+03	8.0874E+02	7.7631E+01	2.6757E+01	2.8956E-05	4.5867E+04	4.4598E+00	1.4000E+00
8.0797E+00	5.0578E+03	6.9531E+02	7.4380E+01	2.2184E+01	2.5333E-05	4.5858E+04	4.6115E+00	1.4000E+00
7.8693E+00	5.1064E+03	5.7392E+02	7.1484E+01	1.8216E+01	2.2024E-05	4.5830E+04	4.7758E+00	1.4000E+00
7.6588E+00	5.1485E+03	4.5315E+02	6.8953E+01	1.5032E+01	1.9191E-05	4.5847E+04	4.9360E+00	1.4000E+00
7.4483E+00	5.1789E+03	3.6113E+02	6.6706E+01	1.2878E+01	1.7191E-05	4.5832E+04	5.0698E+00	1.4000E+00
7.2379E+00	5.1823E+03	3.4861E+02	6.4994E+01	1.2345E+01	1.6561E-05	4.6087E+04	5.0848E+00	1.4000E+00
7.0274E+00	5.1946E+03	3.9837E+02	6.0257E+01	1.2895E+01	1.7862E-05	4.4498E+04	5.1827E+00	1.4000E+00
6.8169E+00	5.1652E+03	4.2742E+02	5.8625E+01	1.3141E+01	1.7243E-05	4.6239E+04	5.0180E+00	1.4000E+00
6.6065E+00	5.0972E+03	4.4588E+02	9.1112E+01	1.3095E+01	1.5249E-05	5.0538E+04	4.6673E+00	1.4000E+00

SIMILAR OUTPUT FOR PLANES 3-25 AT STATION 487 REMOVED

ALSO, ALL REMAINING FIELD PRINTOUT, REMOVED

MACH NO = 15.000 ANGLE OF ATTACK = 7.500 ANGLE OF SIDESLIP = 0.000 Z0 = 0.000

SURFACE PRESSURE RATIO

Z+Z0	0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	97.5	105.0
20.106	13.304	13.095	12.887	12.293	11.699	10.810	9.922	8.855	7.787	6.696	5.604	4.732	3.860	3.347	2.834
20.644	13.293	13.072	12.865	12.279	11.692	10.822	9.948	8.901	7.845	6.743	5.629	4.701	3.775	3.219	2.684
21.222	13.226	13.012	12.809	12.229	11.648	10.792	9.931	8.907	7.872	6.778	5.680	4.715	3.775	3.176	2.615
21.840	13.158	12.940	12.740	12.163	11.588	10.743	9.894	8.891	7.880	6.802	5.731	4.744	3.802	3.159	2.572
22.498	13.086	12.863	12.667	12.092	11.521	10.684	9.845	8.861	7.873	6.817	5.776	4.780	3.840	3.156	2.543
23.200	13.017	12.787	12.595	12.020	11.454	10.622	9.792	8.822	7.854	6.824	5.812	4.818	3.882	3.163	2.525
23.940	12.946	12.711	12.522	11.948	11.387	10.557	9.736	8.776	7.825	6.821	5.836	4.854	3.926	3.179	2.517
24.716	12.872	12.632	12.446	11.873	11.318	10.490	9.677	8.725	7.787	6.807	5.847	4.885	3.968	3.202	2.519
25.524	12.798	12.553	12.371	11.797	11.247	10.421	9.615	8.669	7.742	6.783	5.845	4.908	4.005	3.229	2.529
26.365	12.736	12.484	12.305	11.729	11.181	10.356	9.554	8.613	7.693	6.750	5.830	4.920	4.036	3.258	2.546
27.233	12.699	12.438	12.261	11.678	11.129	10.300	9.500	8.560	7.644	6.713	5.808	4.923	4.059	3.285	2.566
28.145	12.692	12.420	12.245	11.650	11.098	10.260	9.456	8.514	7.599	6.675	5.779	4.917	4.075	3.310	2.588
29.086	12.714	12.430	12.257	11.648	11.090	10.240	9.429	8.480	7.562	6.639	5.749	4.905	4.083	3.332	2.611
30.063	12.752	12.461	12.286	11.668	11.103	10.241	9.418	8.459	7.533	6.609	5.719	4.889	4.084	3.348	2.633
31.077	12.787	12.505	12.318	11.705	11.128	10.260	9.424	8.455	7.517	6.587	5.692	4.871	4.080	3.361	2.654
32.130	12.799	12.549	12.338	11.746	11.152	10.290	9.441	8.464	7.513	6.574	5.671	4.854	4.073	3.369	2.672
33.225	12.774	12.574	12.333	11.773	11.165	10.320	9.461	8.483	7.519	6.572	5.657	4.840	4.063	3.373	2.688

MACH NO = 15.000 ANGLE OF ATTACK = 7.500 ANGLE OF SIDESLIP = 0.000 Z0 = 0.000

S U R F A C E P R E S S U R E R A T I O

Z+Z0	112.5	120.0	127.5	135.0	142.5	150.0	157.5	165.0	172.5	180.0
20.106	2.610	2.386	2.352	2.318	2.462	2.606	2.899	3.193	3.381	3.569
20.644	2.443	2.225	2.177	2.149	2.276	2.420	2.712	2.990	3.236	3.355
21.222	2.345	2.105	2.039	1.997	2.111	2.246	2.536	2.815	3.083	3.195
21.840	2.272	2.007	1.922	1.864	1.961	2.086	2.369	2.650	2.932	3.044
22.498	2.211	1.922	1.817	1.744	1.826	1.939	2.211	2.491	2.783	2.895
23.200	2.160	1.849	1.725	1.636	1.703	1.804	2.063	2.340	2.635	2.748
23.940	2.121	1.787	1.644	1.541	1.592	1.681	1.927	2.198	2.493	2.606
24.716	2.093	1.736	1.575	1.457	1.494	1.572	1.803	2.067	2.357	2.469
25.524	2.076	1.697	1.518	1.385	1.408	1.475	1.692	1.947	2.228	2.339
26.365	2.068	1.667	1.470	1.324	1.333	1.390	1.592	1.838	2.108	2.215
27.233	2.068	1.647	1.432	1.272	1.268	1.315	1.504	1.738	1.995	2.099
28.145	2.073	1.633	1.402	1.228	1.212	1.250	1.426	1.648	1.891	1.989
29.086	2.083	1.626	1.379	1.192	1.164	1.193	1.358	1.567	1.794	1.885
30.063	2.095	1.624	1.361	1.163	1.124	1.145	1.298	1.494	1.704	1.788
31.077	2.109	1.625	1.348	1.138	1.089	1.103	1.246	1.428	1.620	1.697
32.130	2.124	1.630	1.339	1.118	1.059	1.067	1.200	1.368	1.543	1.611
33.225	2.139	1.638	1.333	1.102	1.033	1.036	1.160	1.314	1.470	1.531

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                              A E R O D Y N A M I C   D A T A

                          F R E E   S T R E A M   C O N D I T I O N S
MACH NO. =   1.500000E+01        ANGLE OF ATTACK =   7.500000E+00   ANGLE OF SIDESLIP =   0.
    VINF =   5.612486E+03  TOTAL ANGLE OF ATTACK =   7.500000E+00     AERO ROLL ANGLE =   0.
    PINF =   1.000000E+00                   DINF =   1.000000E-05                SINF =   0.
PERFECT GAS    (GAMMA =    1.400000E+00)

                          R E F E R E N C E   Q U A N T I T I E S
REFERENCE LENGTH IS   3.300000E+01      REFERENCE AREA IS   1.879407E+02      ZO IS   0.

            A E R O D Y N A M I C   C O E F F I C I E N T S   A T   T A R G E T E D   Z   L O C A T I O N S
               FORCE COEFFICIENTS                  MOMENT COEFFICIENTS ABOUT Z =   0.                CENTERS OF PRESSURE
    Z+ZO          CN             CA             CY             CMN             CMM          CML             XCPP           XCPY
   33.000    2.20658E-01    1.75140E-01    -0.            -0.           -1.04908E-01    -0.          4.75434E-01              I
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A E R O D Y N A M I C   D A T A

Z DERIVATIVES OF FORCE AND MOMENT COEFFICIENTS

Z+Z0	CNZ	CAZ	CYZ	CMNZ	CMMZ	CMLZ
20.106	3.59043E-03	6.29091E-04	-0.	-0.	-2.25042E-03	-0.
20.644	3.69643E-03	6.23642E-04	-0.	-0.	-2.37756E-03	-0.
21.222	3.78002E-03	6.19560E-04	-0.	-0.	-2.49812E-03	-0.
21.840	3.85357E-03	6.16060E-04	-0.	-0.	-2.61937E-03	-0.
22.498	3.92183E-03	6.13014E-04	-0.	-0.	-2.74463E-03	-0.
23.200	3.98763E-03	6.10581E-04	-0.	-0.	-2.87614E-03	-0.
23.940	4.04980E-03	6.08712E-04	-0.	-0.	-3.01250E-03	-0.
24.716	4.10713E-03	6.07271E-04	-0.	-0.	-3.15239E-03	-0.
25.524	4.16038E-03	6.06281E-04	-0.	-0.	-3.29593E-03	-0.
26.365	4.21272E-03	6.05983E-04	-0.	-0.	-3.44557E-03	-0.
27.238	4.26829E-03	6.06719E-04	-0.	-0.	-3.60488E-03	-0.
28.145	4.33036E-03	6.08767E-04	-0.	-0.	-3.77723E-03	-0.
29.086	4.40051E-03	6.12247E-04	-0.	-0.	-3.96487E-03	-0.
30.063	4.47855E-03	6.17115E-04	-0.	-0.	-4.16874E-03	-0.
31.077	4.56261E-03	6.23165E-04	-0.	-0.	-4.38822E-03	-0.
32.130	4.64893E-03	6.30006E-04	-0.	-0.	-4.62075E-03	-0.
33.225	4.73214E-03	6.37080E-04	-0.	-0.	-4.86173E-03	-0.

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          PROGRAM D3CSS       VERSION  10       DATE   03/21/77        TIME   19.13.39
3-D SUPERSONIC FLOW  -  FLOW IS NONSYMMETRICAL
MAXIMUM NO. OF STEPS = 2000        LAST Z VALUE =   6.000000E+01       CFL FACTOR =  .900
ERROR LIMIT    1.0000E-03  MAXIMUM NUMBER OF ITERATIONS   20
PRINT CONTROLS ARE      ZPRINT  1000000.00  1000000.00  1000000.00  1000000.00  1000000.00
                        KOUT            100          20          20          20          20
                        DZPRINT 1000000.00
MACH NO. =   15.00        ANGLE OF ATTACK =    7.50       YAW ANGLE =   0.00   VINF =   5612.49
FREE STREAM PROPERTIES . PINF =   1.0000E+00 DINF =   1.0000E-05 HINF =   3.5000E+05 HO =   1.6100E+07 SINF =   0.
PERFECT GAS   (GAMMA =  1.40    GAS CONSTANT =   1.020191E+04)
FLOW IS PERIODIC WITH PERIOD = 180.00
CALC. BEGINS AT Z =   .3322524E+02
RADIAL INTERVALS NA =  12       TANGENTIAL INTERVALS MA =  32
REZONE THE MESH IN THIS RUN

          PROGRAM BODY       VERSION   3
BODY IS SPHERICALLY BLUNTED AND SPHERE ENDS AT Z=   .6579799E+00   WITH B=   .9396926E+00
 AFT BODY IS A MULTIPLE CONIC WITH
     ANGLE   20.0000 UP TO    15.0000
     ANGLE    5.0000 UP TO **********
THERE IS A WIND CUT OF
     ANGLE    0.0000 BEGINNING AT   35.0000
     ANGLE    0.0000 BEGINNING AT   50.0000
         WITH A FLAP OF HALF-WIDTH    4.7415 LENGTH ALONG Z-AXIS     12.0000   AT    5.0000 DEGREES

          PROGRAM TRANG       VERSION   1
THE PHI"S WERE READ IN BY THE USER

          PROGRAM TRANF       VERSION   1
EQUAL SPACING IN RADIAL DIRECTION




              ADDITIONAL FEATURES

BACKWARD DIFFERENCE FOR PREDICTOR STEP AND FORWARD DIFFERENCE FOR CORRECTOR STEP IN X DIRECTION

WALL ENTROPY EXTRAPOLATION FOR 33 PLANES UNTIL A COMPRESSION JUMP AND THEN NO EXTRAPOLATION

MOD 3 FOR WALL POINTS UNTIL A JUMP OCCURS AND THEN MOD 0 IS USED

SECOND ORDER ACCURACY IS USED AT WALL POINTS FOR Z LESS THAN   1.000000E+06 OR UNTIL JUMP IS CALLED

IF PRESSURE IS NEGATIVE THEN THE CONSERVATION VECTORS ARE SMOOTHED BY 1- 2-1

USING JUMP WHICH COMPUTES JUMPS CORRESPONDING TO DISCONTS. IN BZ AND/OR BPHI EXCEPT FOR THE PHI INTERVAL (   0.00,   0.00)

THE CFL FACTOR IS REDUCED TO  .300 WHEN Z IS IN THE INTERVAL (    0.00,    0.00)

USE CFL FACTOR =  .300 FOR  0 STEPS AFTER AN EXPANSION JUMP OCCURS

THE TERMS FOR X DERIVATIVES AT THE WALL ARE MODIFIED FOR
       0 STEPS AFTER AN EXPANSION JUMP AND  4 STEPS AFTER A COMPRESSION JUMP
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MACH NO IS 1.5000000E+01 ANGLE OF ATTACK IS 7.5000000E+00 ANGLE OF SIDESLIP IS 0.

PLANE 1 ANGLE IS 0.00 DEGREES
THE AXIS IS SHIFTED UP 0.0000 UNITS

STATION 503 Z IS 3.3225239E+01 B IS 7.7542629E+00 BZ IS 8.7488664E-02 BPHI IS 0.
C IS 1.2034917E+01 CZ IS 1.5020041E-01 CPHI IS 0.

R	W	U	V	P	RHO	S	M	GAMMA
1.2035E+01	5.3837E+03	4.7117E+02	0.	1.9879E+01	4.6476E-05	2.1393E+04	6.9837E+00	1.4000E+00
1.1678E+01	5.3670E+03	3.9414E+02	0.	1.6607E+01	3.5880E-05	2.6046E+04	6.6852E+00	1.4000E+00
1.1321E+01	5.3421E+03	3.2478E+02	0.	1.4223E+01	2.7990E-05	3.0959E+04	6.3454E+00	1.4000E+00
1.0965E+01	5.3115E+03	2.5917E+02	0.	1.2448E+01	2.2223E-05	3.5799E+04	6.0051E+00	1.4000E+00
1.0609E+01	5.2779E+03	2.1543E+02	0.	1.1411E+01	1.8587E-05	3.9960E+04	5.6976E+00	1.4000E+00
1.0251E+01	5.2429E+03	2.1674E+02	0.	1.1258E+01	1.6892E-05	4.3029E+04	5.4323E+00	1.4000E+00
9.8946E+00	5.2105E+03	2.6273E+02	0.	1.1842E+01	1.6640E-05	4.4856E+04	5.2267E+00	1.4000E+00
9.5379E+00	5.1915E+03	2.9956E+02	0.	1.2241E+01	1.6611E-05	4.5764E+04	5.1196E+00	1.4000E+00
9.1811E+00	5.1898E+03	3.1566E+02	0.	1.2240E+01	1.6584E-05	4.5821E+04	5.1148E+00	1.4000E+00
8.8244E+00	5.1811E+03	3.4012E+02	0.	1.2345E+01	1.6490E-05	4.6240E+04	5.0718E+00	1.4000E+00
8.4677E+00	5.1827E+03	3.7568E+02	0.	1.2562E+01	1.6915E-05	4.5776E+04	5.0961E+00	1.4000E+00
8.1110E+00	5.1779E+03	4.1238E+02	0.	1.2725E+01	1.7067E-05	4.5785E+04	5.0842E+00	1.4000E+00
7.7543E+00	5.1734E+03	4.5261E+02	0.	1.2774E+01	1.7092E-05	4.5831E+04	5.0770E+00	1.4000E+00

PLANE 2 ANGLE IS 4.00 DEGREES
THE AXIS IS SHIFTED UP 0.0000 UNITS

STATION 503 Z IS 3.3225239E+01 B IS 7.7542629E+00 BZ IS 8.7488664E-02 BPHI IS 0.
C IS 1.2042504E+01 CZ IS 1.5064889E-01 CPHI IS 8.7098612E-02

R	W	U	V	P	RHO	S	M	GAMMA
1.2043E+01	5.3833E+03	4.7409E+02	4.2302E+01	1.9871E+01	4.6471E-[illegible]	2.1386E+04	6.9850E+00	1.4000E+00
1.1685E+01	5.3667E+03	3.9690E+02	4.2361E+01	1.6591E+01	3.5853E-05	2.6047E+04	6.6861E+00	1.4000E+00
1.1329E+01	5.3418E+03	3.2722E+02	4.2349E+01	1.4201E+01	2.7954E-05	3.0967E+04	6.3462E+00	1.4000E+00
1.0970E+01	5.3115E+03	2.6113E+02	4.2382E+01	1.2420E+01	2.2188E-05	3.5797E+04	6.0075E+00	1.4000E+00
1.0613E+01	5.2785E+03	2.1628E+02	4.2370E+01	1.1365E+01	1.8547E-05	3.9933E+04	5.7039E+00	1.4000E+00
1.0256E+01	5.2444E+03	2.1566E+02	4.2343E+01	1.1180E+01	1.6837E-05	4.2969E+04	5.4440E+00	1.4000E+00
9.8994E+00	5.2126E+03	2.6080E+02	4.2191E+01	1.1748E+01	1.6585E-05	4.4772E+04	5.2411E+00	1.4000E+00
9.5410E+00	5.1937E+03	2.9841E+02	4.1908E+01	1.2159E+01	1.6575E-05	4.5670E+04	5.1335E+00	1.4000E+00
9.1837E+00	5.1920E+03	3.1454E+02	4.1248E+01	1.2159E+01	1.6550E-05	4.5724E+04	5.1289E+00	1.4000E+00
8.8263E+00	5.1834E+03	3.3833E+02	4.1134E+01	1.2253E+01	1.6444E-05	4.6150E+04	5.0859E+00	1.4000E+00
8.4690E+00	5.1851E+03	3.7363E+02	4.0120E+01	1.2464E+01	1.6866E-05	4.5680E+04	5.1111E+00	1.4000E+00
8.1116E+00	5.1803E+03	4.1097E+02	3.8739E+01	1.2620E+01	1.7007E-05	4.5700E+04	5.0985E+00	1.4000E+00
7.7543E+00	5.1753E+03	4.5277E+02	4.8149E+01	1.2667E+01	1.7023E-05	4.5761E+04	5.0902E+00	1.4000E+00

SIMILAR OUTPUT FOR PLANES 3-33, REMOVED

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    1.0364E+01     5.3949E+03     9.0532E+02     4.5475E-13     1.6786E+00     5.1638E-06     3.6809E+04     8.1090E+00     1.4000E+00
    9.8424E+00     5.2959E+03     8.2898E+02     2.2737E-13     1.5626E+00     3.1553E-06     5.2572E+04     6.4376E+00     1.4000E+00
    9.3203E+00     5.1712E+03     7.5331E+02     2.2737E-13     1.5154E+00     2.1687E-06     6.5178E+04     5.2835E+00     1.4000E+00
    8.7983E+00     5.0703E+03     6.6948E+02     4.5475E-13     1.4913E+00     1.7271E-06     7.2899E+04     4.6515E+00     1.4000E+00
    8.2763E+00     5.0077E+03     5.8363E+02     9.0949E-13     1.4854E+00     1.5331E-06     7.7051E+04     4.3289E+00     1.4000E+00
    7.7543E+00     4.9358E+03     4.3182E+02     1.8190E-12     1.5310E+00     1.4006E-06     8.1051E+04     4.0052E+00     1.4000E+00

K IS  504      DZ IS  1.0330405E+00      CFL IS  7.2601223E-02      NCFL IS  8      MCFL IS  9      JCFL IS  3      Z IS  3.3225239E+01

K IS  505      DZ IS  1.0680413E+00      CFL IS  7.0222006E-02      NCFL IS  8      MCFL IS 10      JCFL IS  3      Z IS  3.4258280E+01

JUMP IS CALLED FOR PLANE   1      PHI IS   0.00      K IS 505      Z IS    3.532632E+01
                          THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ             1.26086E+01    1.69495E-05    4.52814E+02    0.             5.17568E+03    4.57981E+04    1.04145E+06
R,RZ,RPHI,DRP,DRZ,HOT2      7.90953E+00    0.             0.             0.             8.74887E-02    3.22000E+07
                  SUPERSONIC EXPANSION CORNER WHERE
THETA,AMACH,QT,QSM          5.00000E+00    5.09100E+00    0.             5.19545E+03
                          THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ             6.45651E+00    1.05078E-05    0.             0.             5.28194E+03    4.57981E+04    8.60232E+05

JUMP IS CALLED FOR PLANE   2      PHI IS   4.00      K IS 505      Z IS    3.532632E+01
                          THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ             1.25485E+01    1.69347E-05    4.52963E+02    4.92720E+01    5.17739E+03    4.57075E+04    1.03740E+06
R,RZ,RPHI,DRP,DRZ,HOT2      7.92885E+00    0.             5.54439E-01   -6.99268E-02    8.74887E-02    3.22000E+07
                  SUPERSONIC EXPANSION CORNER WHERE
THETA,AMACH,QT,QSM          6.39995E+00    [illegible].94971E+00   -3.29081E+03    4.02288E+03
                          THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ             6.37932E+00    1.04443E-05   -3.16306E-01   -4.52339E+00    5.28436E+03    4.57075E+04    8.55109E+05

K IS  506      DZ IS  1.0644615E+00      CFL IS  7.0458162E-02      NCFL IS  2      MCFL IS  2      JCFL IS  3      Z IS  3.5326321E+01

JUMP IS CALLED FOR PLANE   3      PHI IS   8.00      K IS 506      Z IS    3.639078E+01
                          THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ             1.17180E+01    1.61587E-05    4.53899E+02    3.71091E+01    5.18809E+03    4.56358E+04    1.01526E+06
R,RZ,RPHI,DRP,DRZ,HOT2      7.98727E+00    0.             1.12254E+00   -1.40541E-01    8.74887E-02    3.22000E+07
                  SUPERSONIC EXPANSION CORNER WHERE
THETA,AMACH,QT,QSM          9.42535E+00    2.69272E+00   -4.44549E+03    2.71318E+03
                          THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ             5.72424E+00    9.68581E-06   -1.01940E+01   -7.25343E+01    5.29695E+03    4.56358E+04    8.27389E+05

K IS  507      DZ IS  1.0586996E+00      CFL IS  7.0841625E-02      NCFL IS  2      MCFL IS  3      JCFL IS  3      Z IS  3.6390782E+01

JUMP IS CALLED FOR PLANE   4      PHI IS  12.00      K IS 507      Z IS    3.744948E+01
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                              THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ           1.11764E+01    1.56229E-05    4.54423E+02    8.55464E+01    5.19408E+03    4.56329E+04    1.00154E+06
R,RZ,RPHI,DRP,DRZ,HOT2    8.08624E+00    0.             1.71878E+00   -2.12557E-01    8.74887E-02    3.22000E+07
                     SUPERSONIC EXPANSION CORNER WHERE
THETA,AMACH,QT,QSM        1.29859E+01    1.89745E+00   -4.85659E+03    1.89891E+03
                              THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ           5.18470E+00    9.02514E-06   -1.90335E+01   -8.95455E+01    5.30757E+03    4.56329E+04    8.04261E+05

K IS  508     DZ IS  1.0699083E+00      CFL IS  7.0099466E-02      NCFL IS  2     MCFL IS  4     JCFL IS  3     Z IS  3.7449482E+01

K IS  509     DZ IS  1.1779792E+00      CFL IS  6.3668354E-02      NCFL IS  3     MCFL IS  4     JCFL IS  3     Z IS  3.8519390E+01

JUMP IS CALLED FOR PLANE   5     PHI IS  16.00     K IS 509     Z IS    3.969737E+01
                              THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ           1.03427E+01    1.47850E-05    4.55376E+02    6.41891E+01    5.20497E+03    4.56241E+04    9.79358E+05
R,RZ,RPHI,DRP,DRZ,HOT2    8.22828E+00    0.             2.35942E+00   -2.86745E-01    8.74887E-02    3.22000E+07
                     SUPERSONIC EXPANSION CORNER WHERE
THETA,AMACH,QT,QSM        1.67435E+01    1.47332E+00   -5.01770E+03    1.45803E+03
                              THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ           4.29166E+00    7.88680E-06   -5.25425E+01   -1.83238E+02    5.32490E+03    4.56241E+04    7.61820E+05

K IS  510     DZ IS  1.0952720E+00      CFL IS  6.8476139E-02      NCFL IS  2     MCFL IS  5     JCFL IS  3     Z IS  3.9697369E+01

K IS  511     DZ IS  1.2086977E+00      CFL IS  6.2050256E-02      NCFL IS  3     MCFL IS  5     JCFL IS  3     Z IS  4.0792642E+01

JUMP IS CALLED FOR PLANE   6     PHI IS  20.00     K IS 511     Z IS    4.200134E+01
                              THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ           9.45284E+00    1.39112E-05    4.56498E+02    9.78320E+01    5.21780E+03    4.55047E+04    9.51319E+05
R,RZ,RPHI,DRP,DRZ,HOT2    8.41715E+00    0.             3.06359E+00   -3.63970E-01    8.74887E-02    3.22000E+07
                     SUPERSONIC EXPANSION CORNER WHERE
THETA,AMACH,QT,QSM        2.05907E+01    1.15301E+00   -5.11651E+03    1.12459E+03
                              THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ           3.31786E+00    6.58386E-06   -8.95823E+01   -2.46125E+02    5.34825E+03    4.55047E+04    7.05514E+05

K IS  512     DZ IS  1.1310307E+00      CFL IS  6.6311199E-02      NCFL IS  2     MCFL IS  6     JCFL IS  3     Z IS  4.2001339E+01

K IS  513     DZ IS  1.2496533E+00      CFL IS  6.0016646E-02      NCFL IS  3     MCFL IS  6     JCFL IS  3     Z IS  4.3132370E+01

JUMP IS CALLED FOR PLANE   7     PHI IS  24.00     K IS 513     Z IS    4.438202E+01
                              THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ           8.77736E+00    1.32423E-05    4.57401E+02    1.33394E+02    5.22812E+03    4.53733E+04    9.27959E+05
R,RZ,RPHI,DRP,DRZ,HOT2    8.65806E+00    0.             3.85482E+00   -4.45229E-01    8.74887E-02    3.22000E+07
                              THE OUTPUT VARIABLES ARE AS FOLLOWS
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P,D,U,V,W,S,ASQ            8.77736E+00    1.32423E-05    9.38632E+01    2.10820E+02    5.24471E+03    4.53733E+04    9.27959E+05

K IS  514     DZ IS  1.1612679E+00     CFL IS  6.4584579E-02     NCFL IS  2     MCFL IS  7     JCFL IS  3     Z IS  4.4382023E+01

K IS  515     DZ IS  1.2508140E+00     CFL IS  5.9960956E-02     NCFL IS  1     MCFL IS  6     JCFL IS  3     Z IS  4.5543291E+01

K IS  516     DZ IS  1.3192493E+00     CFL IS  5.6850515E-02     NCFL IS  1     MCFL IS  6     JCFL IS  3     Z IS  4.6794105E+01

JUMP IS CALLED FOR PLANE   8     PHI IS  28.00     K IS 516     Z IS   4.811335E+01
                              THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            8.51535E+00    1.29156E-05    4.57643E+02    1.15350E+02    5.23088E+03    4.54923E+04    9.23031E+05
R,RZ,RPHI,DRP,DRZ,HOT2     8.95810E+00    0.             4.76311E+00   -5.31709E-01    8.74887E-02    3.22000E+07
                              THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            8.51535E+00    1.29156E-05    1.07804E+02    2.02751E+02    5.24711E+03    4.54923E+04    9.23031E+05

K IS  517     DZ IS  1.1558088E+00     CFL IS  6.4889623E-02     NCFL IS  2     MCFL IS  8     JCFL IS  3     Z IS  4.8113354E+01

K IS  518     DZ IS  1.2890570E+00     CFL IS  5.8182068E-02     NCFL IS  2     MCFL IS  8     JCFL IS  3     Z IS  4.9269163E+01

JUMP IS CALLED FOR PLANE   1     PHI IS   0.00     K IS 518     Z IS   5.055822E+01
                              THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            6.74487E+00    1.07070E-05    0.             0.             5.27165E+03    4.62439E+04    8.81932E+05
R,RZ,RPHI,DRP,DRZ,HOT2     7.95837E+00    8.74887E-02    0.             0.            -8.74887E-02    3.22000E+07
                        SUPERSONIC COMPRESSION CORNER WHERE
THETA,AMACH,QT,QSM         5.00000E+00    5.61344E+00    0.            -5.27165E+03
                              THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            1.30105E+01    1.69791E-05    4.51498E+02    0.             5.16065E+03    4.65361E+04    1.07278E+06

JUMP IS CALLED FOR PLANE   2     PHI IS   4.00     K IS 518     Z IS   5.055822E+01
                              THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            6.76744E+00    1.07518E-05   -4.31233E+00   -6.20500E+01    5.27164E+03    4.61798E+04    8.81189E+05
R,RZ,RPHI,DRP,DRZ,HOT2     7.97781E+00    8.77023E-02    5.57863E-01   -4.29118E-04   -8.77023E-02    3.22000E+07
                        SUPERSONIC COMPRESSION CORNER WHERE
THETA,AMACH,QT,QSM         5.00006E+00    5.61540E+00   -8.79301E+01   -5.27127E+03
                              THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            1.30569E+01    1.70528E-05    4.46037E+02   -9.38912E+01    5.16067E+03    4.64722E+04    1.07195E+06

JUMP IS CALLED FOR PLANE   3     PHI IS   8.00     K IS 518     Z IS   5.055822E+01
                              THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            6.71184E+00    1.07198E-05   -1.54770E+01   -1.10804E+02    5.27301E+03    4.60761E+04    8.76565E+05
R,RZ,RPHI,DRP,DRZ,HOT2     8.03658E+00    8.83485E-02    1.12947E+00   -8.62453E-04   -8.83485E-02    3.22000E+07
                        SUPERSONIC COMPRESSION CORNER WHERE
THETA,AMACH,QT,QSM         5.00023E+00    5.63063E+00   -1.62852E+02   -5.27168E+03
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                              THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            1.29711E+01   1.70209E-05   4.31577E+02   -1.74329E+02   5.16226E+03   4.63707E+04   1.06689E+06

JUMP IS CALLED FOR PLANE   4     PHI IS  12.00     K IS 518     Z IS    5.055822E+01
                              THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            6.62402E+00   1.05916E-05  -3.11452E+01   -1.47431E+02   5.27252E+03   4.61695E+04   8.75562E+05
R,RZ,RPHI,DRP,DRZ,HOT2     8.13617E+00   8.94432E-02   1.72940E+00   -1.30439E-03  -8.94432E-02   3.22000E+07
                        SUPERSONIC COMPRESSION CORNER WHERE
THETA,AMACH,QT,QSM         5.00051E+00   5.63188E+00  -2.25893E+02   -5.26984E+03
                              THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            1.28035E+01   1.68194E-05   4.10192E+02   -2.42279E+02   5.16182E+03   4.64644E+04   1.06573E+06

JUMP IS CALLED FOR PLANE   5     PHI IS  16.00     K IS 518     Z IS    5.055822E+01
                              THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            6.29791E+00   1.02647E-05  -4.56280E+01   -1.60106E+02   5.27991E+03   4.60015E+04   8.58971E+05
R,RZ,RPHI,DRP,DRZ,HOT2     8.27909E+00   9.10144E-02   2.37399E+00   -1.75966E-03  -9.10144E-02   3.22000E+07
                        SUPERSONIC COMPRESSION CORNER WHERE
THETA,AMACH,QT,QSM         5.00087E+00   5.69256E+00  -2.64608E+02   -5.27590E+03
                              THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            1.22531E+01   1.63726E-05   3.88542E+02   -2.85964E+02   5.16996E+03   4.63051E+04   1.04775E+06

JUMP IS CALLED FOR PLANE   6     PHI IS  20.00     K IS 518     Z IS    5.055822E+01
                              THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            5.60295E+00   9.50738E-06  -5.38703E+01   -1.48921E+02   5.29619E+03   4.57560E+04   8.25057E+05
R,RZ,RPHI,DRP,DRZ,HOT2     8.46912E+00   9.31035E-02   3.08251E+00   -2.23357E-03  -9.31035E-02   3.22000E+07
                        SUPERSONIC COMPRESSION CORNER WHERE
THETA,AMACH,QT,QSM         5.00128E+00   5.82530E+00  -2.77774E+02   -5.29127E+03
                              THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            1.10574E+01   1.53112E-05   3.71807E+02   -3.05505E+02   5.18779E+03   4.60794E+04   1.01105E+06

JUMP IS CALLED FOR PLANE   7     PHI IS  24.00     K IS 518     Z IS    5.055822E+01
                              THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            4.74600E+00   8.53700E-06  -3.58520E+01   -8.10222E+01   5.31983E+03   4.53665E+04   7.78306E+05
R,RZ,RPHI,DRP,DRZ,HOT2     8.71152E+00   9.57683E-02   3.87862E+00   -2.73222E-03  -9.57683E-02   3.22000E+07
                        SUPERSONIC COMPRESSION CORNER WHERE
THETA,AMACH,QT,QSM         5.00171E+00   6.02541E+00  -2.27314E+02   -5.31571E+03
                              THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            9.56881E+00   1.39480E-05   3.79955E+02   -2.68046E+02   5.21359E+03   4.57212E+04   9.60446E+05

JUMP IS CALLED FOR PLANE   8     PHI IS  28.00     K IS 518     Z IS    5.055822E+01
                              THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ            4.70009E+00   8.48995E-06   4.45871E+01    8.43739E+01   5.32125E+03   4.53159E+04   7.75049E+05
R,RZ,RPHI,DRP,DRZ,HOT2     9.01341E+00   9.90870E-02   4.79252E+00   -3.26293E-03  -9.90870E-02   3.22000E+07
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                          SUPERSONIC COMPRESSION CORNER WHERE
THETA,AMACH,DT,DSM             5.00212E+00    6.04493E+00   -5.94707E+01   -5.32177E+03
                                  THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ                9.49649E+00    1.38911E-05    4.46755E+02   -1.31645E+02    5.21513E+03    4.56739E+04    9.57096E+05

K IS  519     DZ IS  1.1173726E+00     CFL IS  6.7121748E-02     NCFL IS  2     MCFL IS  8     JCFL IS  3     Z IS  5.0558220E+01

JUMP IS CALLED FOR PLANE   9      PHI IS  32.00       K IS 519       Z IS    5.167559E+01
                                  THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ                7.68552E+00    1.20572E-05    4.58534E+02    2.42858E+02    5.24107E+03    4.53331E+04    8.92393E+05
R,RZ,RPHI,DRP,DRZ,HOT2         9.32675E+00    0.             5.82800E+00   -6.248869E-01    8.74887E-02    3.22000E+07
                                  THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ                7.68552E+00    1.20572E-05    1.98452E+02    3.17589E+02    5.25336E+03    4.53331E+04    8.92393E+05

K IS  520     DZ IS  1.1379774E+00     CFL IS  6.5906404E-02     NCFL IS  1     MCFL IS  9     JCFL IS  3     Z IS  5.1675593E+01

K IS  521     DZ IS  1.1460533E+00     CFL IS  6.5441985E-02     NCFL IS  3     MCFL IS  8     JCFL IS  3     Z IS  5.2813570E+01

K IS  522     DZ IS  1.1536796E+00     CFL IS  6.5009382E-02     NCFL IS  4     MCFL IS  8     JCFL IS  3     Z IS  5.3959623E+01

K IS  523     DZ IS  1.1520580E+00     CFL IS  6.5100889E-02     NCFL IS  4     MCFL IS  8     JCFL IS  3     Z IS  5.5113303E+01

K IS  524     DZ IS  1.1545349E+00     CFL IS  6.4961224E-02     NCFL IS  4     MCFL IS  8     JCFL IS  3     Z IS  5.6265361E+01

JUMP IS CALLED FOR PLANE  10      PHI IS  36.00       K IS 524       Z IS    5.741990E+01
                                  THE INPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ                8.72084E+00    1.32520E-05    4.57635E+02    1.51017E+02    5.23080E+03    4.51823E+04    9.21306E+05
R,RZ,RPHI,DRP,DRZ,HOT2         9.77672E+00    0.             7.10320E+00   -7.26543E-01    8.74887E-02    3.22000E+07
                                  THE OUTPUT VARIABLES ARE AS FOLLOWS
P,D,U,V,W,S,ASQ                8.72084E+00    1.32520E-05    1.76279E+02    2.42628E+02    5.24438E+03    4.51823E+04    9.21306E+05

K IS  525     DZ IS  1.1440479E+00     CFL IS  6.5556697E-02     NCFL IS  1     MCFL IS 10     JCFL IS  3     Z IS  5.7419896E+01

K IS  526     DZ IS  1.1621301E+00     CFL IS  6.4536664E-02     NCFL IS  4     MCFL IS  8     JCFL IS  3     Z IS  5.8563944E+01

K IS  527     DZ IS  1.1666301E+00     CFL IS  6.4287728E-02     NCFL IS  4     MCFL IS  8     JCFL IS  3     Z IS  5.9726074E+01
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FIELD PRINTOUT FOR STATION 527, REMOVED

MACH NO = 15.000 ANGLE OF ATTACK = 7.500 ANGLE OF SIDESLIP = 0.000 ZO = 0.000

SURFACE PRESSURE RATIO

Z+ZO	0.0	4.0	8.0	12.0	16.0	20.0	24.0	28.0	32.0	36.0	40.0	44.0	48.0	52.0	56.0
33.225	12.774	12.667	12.558	12.429	12.259	11.960	11.651	11.327	10.939	10.489	10.033	9.575	9.070	8.548	8.033
34.258	12.707	12.622	12.543	12.406	12.219	11.939	11.645	11.317	10.927	10.492	10.046	9.584	9.078	8.564	8.048
35.326	6.457	6.379	12.495	12.352	12.152	11.891	11.612	11.282	10.894	10.475	10.041	9.580	9.079	8.573	8.061
36.391	6.934	6.886	5.724	12.264	12.058	11.812	11.545	11.216	10.834	10.431	10.009	9.553	9.062	8.566	8.062
37.449	7.013	6.902	6.376	5.185	11.949	11.711	11.452	11.126	10.752	10.363	9.952	9.504	9.024	8.542	8.046
38.519	7.041	6.986	6.486	5.955	10.719	11.596	11.338	11.016	10.652	10.275	9.873	9.433	8.967	8.498	8.012
39.697	7.021	6.990	6.612	6.317	4.292	11.169	11.203	10.883	10.531	10.165	9.770	9.340	8.888	8.433	7.959
40.793	7.008	6.981	6.760	6.321	5.212	9.817	11.005	10.748	10.405	10.047	9.656	9.233	8.794	8.351	7.887
42.001	6.979	6.969	6.790	6.452	5.667	3.318	10.551	10.584	10.269	9.917	9.530	9.113	8.686	8.254	7.800
43.132	6.952	6.956	6.902	6.596	5.787	4.459	9.113	10.366	10.134	9.792	9.406	8.994	8.576	8.151	7.705
44.382	6.909	6.925	6.817	6.608	6.015	5.128	8.777	9.909	9.972	9.661	9.278	8.871	8.458	8.040	7.601
45.543	6.876	6.903	6.822	6.625	6.210	5.218	5.866	9.936	9.759	9.534	9.161	8.757	8.348	7.933	7.499
46.794	6.835	6.869	6.806	6.654	6.324	5.205	4.759	9.029	9.570	9.384	9.045	8.646	8.239	7.826	7.395
48.113	6.794	6.830	6.779	6.679	6.327	5.258	4.543	8.515	8.984	9.225	8.922	8.539	8.133	7.719	7.291
49.263	6.776	6.807	6.758	6.674	6.311	5.376	4.573	5.922	8.911	8.985	8.810	8.447	8.044	7.629	7.201
50.559	13.011	13.057	12.971	12.804	12.253	11.057	9.569	9.496	8.201	8.788	8.655	8.354	7.959	7.542	7.114
51.676	13.212	13.260	13.122	12.888	12.269	11.101	9.591	9.096	7.686	8.385	8.519	8.262	7.888	7.472	7.043
52.814	13.527	13.526	13.293	12.926	12.291	11.289	9.670	8.439	5.898	8.503	8.334	8.169	7.820	7.410	6.980
53.960	13.494	13.459	13.171	12.772	12.281	11.597	10.015	8.494	5.279	8.128	8.202	8.058	7.753	7.353	6.925
55.113	13.182	13.139	12.865	12.546	12.289	11.948	10.519	8.902	5.292	8.075	7.920	7.954	7.680	7.300	6.876
56.265	12.935	12.893	12.647	12.402	12.283	12.134	10.851	9.173	5.517	8.331	7.658	7.821	7.606	7.247	6.832
57.420	12.765	12.731	12.522	12.333	12.269	12.209	11.056	9.357	5.778	8.721	7.478	7.696	7.522	7.195	6.792
58.564	12.660	12.637	12.464	12.309	12.240	12.205	11.170	9.500	6.029	6.875	7.737	7.613	7.436	7.141	6.755
59.726	12.589	12.581	12.443	12.304	12.195	12.150	11.233	9.636	6.235	6.227	7.473	7.624	7.358	7.084	6.718
60.892	12.543	12.548	12.439	12.301	12.134	12.059	11.254	9.750	6.391	6.298	7.415	7.479	7.306	7.029	6.680

MACH NO = 15.000 ANGLE OF ATTACK = 7.500 ANGLE OF SIDESLIP = 0.000 Z0 = 0.000

SURFACE PRESSURE RATIO

7+Z0	60.0	64.0	68.0	72.0	76.0	80.0	84.0	88.0	92.0	96.0	100.3	105.4	112.2	121.7	134.0
33.225	7.519	7.014	6.511	6.023	5.548	5.112	4.684	4.270	3.879	3.508	3.118	2.661	2.161	1.571	1.134
34.258	7.529	7.018	6.515	6.019	5.541	5.099	4.673	4.257	3.870	3.502	3.117	2.676	2.177	1.581	1.128
35.326	7.542	7.028	6.525	6.027	5.542	5.095	4.667	4.251	3.863	3.499	3.118	2.685	2.191	1.590	1.123
36.391	7.547	7.036	6.533	6.035	5.547	5.096	4.665	4.249	3.859	3.496	3.119	2.690	2.202	1.599	1.119
37.449	7.539	7.037	6.537	6.040	5.553	5.101	4.667	4.249	3.858	3.496	3.121	2.695	2.210	1.608	1.116
38.519	7.515	7.026	6.533	6.041	5.557	5.107	4.672	4.251	3.858	3.496	3.124	2.700	2.218	1.616	1.114
39.697	7.475	7.001	6.518	6.034	5.557	5.114	4.679	4.256	3.860	3.498	3.131	2.709	2.227	1.625	1.114
40.793	7.415	6.955	6.485	6.011	5.543	5.108	4.678	4.257	3.861	3.499	3.132	2.712	2.232	1.633	1.114
42.001	7.340	6.895	6.438	5.976	5.521	5.097	4.674	4.256	3.861	3.501	3.138	2.719	2.240	1.643	1.116
43.132	7.256	6.823	6.377	5.927	5.484	5.073	4.659	4.247	3.858	3.500	3.139	2.722	2.245	1.650	1.119
44.332	7.161	6.739	6.303	5.866	5.437	5.039	4.635	4.233	3.849	3.497	3.142	2.728	2.251	1.660	1.123
45.543	7.067	6.652	6.224	5.797	5.380	4.994	4.600	4.208	3.834	3.489	3.138	2.728	2.255	1.667	1.126
46.794	6.969	6.560	6.139	5.721	5.316	4.940	4.557	4.176	3.812	3.476	3.134	2.729	2.259	1.676	1.131
48.113	6.870	6.465	6.048	5.638	5.243	4.877	4.504	4.134	3.781	3.455	3.124	2.728	2.262	1.684	1.137
49.269	6.783	6.380	5.966	5.561	5.174	4.815	4.448	4.087	3.746	3.430	3.106	2.718	2.260	1.689	1.142
50.558	6.698	6.295	5.882	5.482	5.101	4.748	4.388	4.035	3.704	3.398	3.086	2.708	2.258	1.696	1.148
51.676	6.627	6.223	5.811	5.413	5.036	4.687	4.331	3.985	3.663	3.366	3.061	2.691	2.252	1.699	1.152
52.814	6.563	6.158	5.744	5.349	4.975	4.628	4.275	3.934	3.620	3.332	3.035	2.673	2.244	1.701	1.156
53.960	6.507	6.098	5.683	5.289	4.917	4.571	4.221	3.884	3.576	3.295	3.006	2.653	2.233	1.702	1.161
55.113	6.457	6.044	5.627	5.233	4.862	4.517	4.168	3.835	3.531	3.257	2.975	2.630	2.221	1.702	1.165
56.265	6.413	5.996	5.576	5.182	4.811	4.466	4.118	3.787	3.488	3.218	2.943	2.606	2.207	1.701	1.169
57.420	6.374	5.953	5.530	5.135	4.764	4.417	4.070	3.741	3.445	3.179	2.909	2.579	2.191	1.698	1.173
58.564	6.340	5.916	5.490	5.093	4.720	4.372	4.024	3.697	3.403	3.141	2.875	2.551	2.172	1.693	1.176
59.726	6.310	5.884	5.454	5.055	4.681	4.330	3.981	3.655	3.363	3.103	2.840	2.522	2.152	1.687	1.179
60.893	6.281	5.855	5.424	5.021	4.645	4.291	3.941	3.615	3.325	3.066	2.806	2.492	2.131	1.679	1.181

MACH NO = 15.000 ANGLE OF ATTACK = 7.500 ANGLE OF SIDESLIP = 0.000 Z0 = 0.000

SURFACE PRESSURE RATIO

Z+Z0	148.4	164.0	180.0
33.225	1.035	1.294	1.531
34.258	1.020	1.263	1.441
35.326	1.004	1.227	1.373
36.391	.990	1.192	1.319
37.449	.976	1.159	1.273
38.519	.964	1.129	1.232
39.697	.952	1.098	1.190
40.793	.941	1.074	1.158
42.001	.931	1.049	1.125
43.132	.922	1.029	1.100
44.392	.913	1.007	1.073
45.543	.906	.991	1.054
46.794	.899	.974	1.034
48.113	.893	.957	1.016
49.269	.888	.946	1.006
50.558	.883	.934	.994
51.676	.879	.925	.987
52.814	.875	.917	.981
53.960	.871	.909	.975
55.113	.868	.902	.971
56.265	.865	.895	.967
57.420	.862	.889	.965
58.564	.860	.885	.964
59.726	.858	.880	.964
60.893	.855	.876	.964

A E R O D Y N A M I C   D A T A

F R E E   S T R E A M   C O N D I T I O N S

```
MACH NO. =   1.500000E+01         ANGLE OF ATTACK =   7.500000E+00   ANGLE OF SIDESLIP =   0.
   VINF =    5.612486E+03   TOTAL ANGLE OF ATTACK =   7.500000E+00    AERO ROLL ANGLE =   0.
   PINF =    1.000000E+00                    DINF =   1.000000E-05               SINF =   0.
PERFECT GAS   (GAMMA =   1.400000E+00)
```

R E F E R E N C E   Q U A N T I T I E S

```
REFERENCE LENGTH IS   6.000000E+01      REFERENCE AREA IS   3.202677E+02      Z0 IS   0.
```

A E R O D Y N A M I C   C O E F F I C I E N T S   A T   T A R G E T E D   Z   L O C A T I O N S

	FORCE COEFFICIENTS			MOMENT COEFFICIENTS ABOUT Z = 0.			CENTERS OF PRESSURE	
Z+Z0	CN	CA	CY	CMN	CMM	CML	XCPP	XCPY
60.000	2.00683E-01	1.11425E-01	-0.	-0.	-9.07455E-02	-0.	4.52184E-01	I

A E R O D Y N A M I C   D A T A

Z DERIVATIVES OF FORCE AND MOMENT COEFFICIENTS

Z+Z0	CNZ	CAZ	CYZ	CMNZ	CMMZ	CMLZ
33.225	2.77643E-03	3.74124E-04	-0.	-0.	-1.56885E-03	-0.
34.259	2.81201E-03	3.77623E-04	-0.	-0.	-1.63774E-03	-0.
35.326	2.61804E-03	3.43722E-04	-0.	-0.	-1.56944E-03	-0.
36.391	2.56102E-03	3.31251E-04	-0.	-0.	-1.57993E-03	-0.
37.449	2.38729E-03	3.03692E-04	-0.	-0.	-1.51329E-03	-0.
38.519	2.40902E-03	3.03457E-04	-0.	-0.	-1.57001E-03	-0.
39.697	2.33109E-03	2.90797E-04	-0.	-0.	-1.56431E-03	-0.
40.793	2.31307E-03	2.87738E-04	-0.	-0.	-1.59444E-03	-0.
42.001	2.13969E-03	2.63586E-04	-0.	-0.	-1.51669E-03	-0.
43.132	2.16067E-03	2.61404E-04	-0.	-0.	-1.57205E-03	-0.
44.382	2.19318E-03	2.49045E-04	-0.	-0.	-1.63970E-03	-0.
45.543	2.14837E-03	2.48916E-04	-0.	-0.	-1.64834E-03	-0.
46.794	2.10311E-03	2.46085E-04	-0.	-0.	-1.65770E-03	-0.
48.113	2.13815E-03	2.21689E-04	-0.	-0.	-1.72905E-03	-0.
49.269	2.03856E-03	2.20751E-04	-0.	-0.	-1.68855E-03	-0.
50.553	3.04903E-03	3.91408E-04	-0.	-0.	-2.60668E-03	-0.
51.676	3.09336E-03	3.81140E-04	-0.	-0.	-2.70077E-03	-0.
52.814	3.08289E-03	3.83060E-04	-0.	-0.	-2.75097E-03	-0.
53.960	3.09557E-03	3.84651E-04	-0.	-0.	-2.82198E-03	-0.
55.113	3.13244E-03	3.87376E-04	-0.	-0.	-2.91626E-03	-0.
56.265	3.17471E-03	3.90364E-04	-0.	-0.	-3.01697E-03	-0.
57.420	3.33723E-03	3.69104E-04	-0.	-0.	-3.23130E-03	-0.
58.564	3.29263E-03	3.71699E-04	-0.	-0.	-3.25224E-03	-0.
59.725	3.29581E-03	3.73782E-04	-0.	-0.	-3.31997E-03	-0.
60.893	3.32738E-03	3.75608E-04	-0.	-0.	-3.41686E-03	-0.

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